A COMBINED LIMITED ENERGY STUDY OF ELECTRICAL ENERGY DEMAND AND USE AND HEATING SYSTEMS AT PINE BLUFF ARSENAL, ARKANSAS

VOLUME II
APPENDICES

FINAL SUBMITTAL

Prepared for
U. S. Army Engineer District, Little Rock

Contract Number DACA01-94-D-0038
Delivery Order Number 0004

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September 1996

694-1331-004

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APPENDIX A

A.1 SCOPE OF WORK

CESWL-ED-DM

June 1995

GENERAL SCOPE OF WORK

FOR A

LIMITED ENERGY STUDY, COMBINED

ELECTRICAL DEMAND AND HEATING

PINE BLUFF ARSENAL, ARKANSAS

Performed as part of the

ENERGY ENGINEERING ANALYSIS PROGRAM (EEAP)

SCOPE OF WORK
FOR A
LIMITED ENERGY STUDY, COMBINED
ELECTRICAL DEMAND AND HEATING
PINE BLUFF ARSENAL, ARKANSAS

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ANNEXES

1. <u>BRIEF DESCRIPTION OF WORK</u>. The Architect-Engineer (AE) shall:

1.1 Perform site survey of specific buildings or areas to collect all data required to evaluate the list of possible Energy Conservation Opportunities (ECOs) provided in Annex A and B.

1.2 Evaluate new ECOs discovered by the AE in his site survey to verify their energy savings potential and economic feasibility.

1.3 Provide project administrative/technical documentation (DD Form 1391 and Project Development Brochure (PDB)) for qualifying Energy Conservation Investment Program (ECIP) projects as detailed herein. See Annex D for required documentation.

1.4 Prepare a comprehensive report to document all work (site surveys, evaluations, etc.) performed, the results and all recommendations.

2. <u>GENERAL</u>

2.1 This study is limited to the evaluation of the specific buildings, systems, or ECOs listed in Annex A AND B, DETAILED SCOPE OF WORK (the list of possible ECO's is not all inclusive, the A/E shall alert the Government when new ECOs are discovered).

2.2 The information and analysis outlined herein are considered to be minimum requirements for adequate performance of this work.

2.3 For the buildings, systems, or ECOs listed in Annex A and B, all methods of energy conservation as related to the ECO's, which are reasonable and practicable shall be considered, including improvements of operational methods and procedures as well as changing of the physical facilities. All energy conservation opportunities which produce energy or dollar savings shall be documented in the report. Any energy conservation opportunity considered infeasible shall also be documented in the report with reasons for elimination.

2.4 The study shall consider the use of all energy sources applicable to each building, system, or ECO.

2.5 The "Energy Conservation Investment Program (ECIP) Guidance", described in letter from DAIM-FDF-U, dated 10 January 1994 establishes criteria for ECIP projects and shall be used for performing the economic analyses of <u>all</u> ECOs and projects. The program, Life Cycle Cost In Design (LCCID), has been developed for performing life cycle cost calculations in accordance with ECIP guidelines and is referenced in the ECIP Guidance. If any program other than LCCID is proposed for life cycle cost analysis, it must use the mode of calculation specified in the ECIP Guidance. The output must be in the format of the ECIP LCCA summary sheet, and it must be submitted for approval to the

Contracting Officer.

2.6 Energy conservation opportunities determined to be technically and economically feasible shall be developed into projects acceptable for installation input into DD Form 1391 processor (ready to submit); and hard copy submission of PDB 1 and 2. This may involve combining similar ECOs into larger packages which will qualify for ECIP funding, and determining in coordination with installation personnel the appropriate packaging and implementation approach for all feasible ECOs.

2.6.1 Projects which qualify for ECIP funding shall be identified, separately listed, and prioritized by the Savings to Investment Ratio (SIR).

2.6.2 All feasible non-ECIP projects shall be ranked in order of highest to lowest SIR.

3. <u>PROJECT MANAGEMENT</u>

3.1 <u>Project Managers</u>. The AE shall designate a project manager to serve as a point of contact and liaison for work required under this contract. Upon award of this contract, the individual shall be immediately designated in writing. The AE's designated project manager shall be approved by the Contracting Officer prior to commencement of work. This designated individual shall be responsible for coordination of all work. The Contracting Officer will designate a project manager to serve as the Government's point of contact and liaison for all work. This individual will be the Government's representative.

3.2 <u>Installation Assistance</u>. The Commanding Officer or authorized representative at the installation will designate an individual to assist the AE in obtaining information and establishing contacts necessary to accomplish the work required under this contract. This individual will be the installation administrative representative.

3.3 <u>Public Disclosures</u>. The AE shall make no public announcements or disclosures relative to information contained or developed in this contract, except as authorized by the Contracting Officer.

3.4 <u>Meetings</u>. Meetings will be scheduled whenever requested by the AE or the Government's representative for the resolution of questions or problems encountered in the performance of the work. The AE's project manager and the Government's representative shall be required to attend and participate in all meetings pertinent to the work required under this contract (as directed by the Contracting Officer). These meetings, if necessary, are in addition to the presentation and review conferences.

3.5 <u>Site Visits, Inspections, and Investigations</u>. The AE shall visit and inspect/investigate the site of the project as

necessary and required during the preparation and accomplishment of the work. Specific safety and security requirements to be followed by the AE in site visits are provided in Annex A and B, DETAILED SCOPE OF WORK.

3.6 Records

3.6.1 The AE shall provide a record of all significant conferences, meetings, discussions, verbal directions, telephone conversations, etc., with Government representative(s) relative to this contract in which the AE and/or designated representative(s) thereof participated. These records shall be dated and shall identify the contract number, and modification number if applicable, participating personnel, subject discussed and conclusions reached. The AE shall forward to the Contracting Officer and Government's representative within ten calendar days, a reproducible copy of the records.

3.6.2 The AE shall provide a record of requests for and/or receipt of Government-furnished material, data, documents, information, etc., which if not furnished in a timely manner, would significantly impair the normal progression of the work under this contract. Government-furnished material, data, documents, information, etc. should be returned to the Directorate of Public Works (DPW) at contract completion. The records shall be dated and shall identify the contract number and modification number, if applicable. The AE shall forward to the Contracting Officer and Government representative within ten calendar days, a reproducible copy of the record of request for receipt of items.

3.7 Interviews. The AE and the Government's representative shall conduct entry and exit interviews with the DPW before starting work at the installation and after completion of the field work. The Government's representative shall schedule the interviews at least one week in advance.

3.7.1 Entry. The entry interview shall describe the intended procedures for the survey and shall be conducted prior to commencing work at the facility. As a minimum, the interview shall cover the following points:

a. Schedules.

b. Names of energy analysts who will be conducting the site survey(s).

c. Proposed working hours.

d. Support requirements from the DPW.

3.7.2 Exit. The exit interview shall briefly describe the items surveyed and probable candidates for energy conservation. The interview shall also solicit input and advice from the DPW.

4. SERVICES AND MATERIALS. All services, materials (except those specifically enumerated to be furnished by the Government), plant, labor, measurement equipment, supervision and travel necessary to perform the work and render the data required under this contract are included in the lump sum contract price.

5. PROJECT DOCUMENTATION. All energy conservation opportunities which the AE has considered shall be included in one of the following categories and presented in the report as such:

5.1 ECIP Projects. To qualify as an ECIP project, an ECO, or several ECOs which have been combined, must have a construction cost estimate greater than $300,000, a SIR greater than 1.25 and a simple payback period of less than ten years. The overall project and each discrete part of the project shall have an SIR greater than 1.25. All ECIP qualifying projects shall be arranged as specified in paragraph 2.6.1 and shall be provided with project documentation. Project documentation shall consist of a DD Form 1391 (Section 1-23), life cycle cost analysis (LCCA) summary sheet(s) (with necessary backup data to verify the numbers presented), and a Project Development Brochure (PDB 1/2). See Annex D, Project Documentation, for specific requirements. A life cycle cost analysis summary sheet shall be developed for each ECO and for the overall project when two or more ECOs are combined. The energy savings for projects consisting of multiple ECOs must take into account the synergistic effects of the individual ECOs.

5.2 Non-ECIP Projects. Projects which do not meet ECIP criteria with regard to cost estimate or payback period, but which have an SIR greater than 1.25 shall be documented. Projects or ECOs in this category shall be arranged as specified in paragraph 2.6.2 and shall be provided with the following documentation: the life cycle cost analysis (LCCA) summary sheet completely filled out, a description of the work to be accomplished; backup data for the LCCA, i.e., energy savings calculations and cost estimate(s); and the simple payback period. The energy savings for projects consisting of multiple ECOs must take into account the synergistic effects of the individual ECOs. In addition, these projects shall have the necessary documentation prepared for the following category: Low Cost/No Cost Projects. These are projects which the DPW can perform using his resources. Documentation shall be as required by the DPW.

5.3 Nonfeasible ECOs. All ECOs which the AE has considered but which are not feasible, shall be documented in the report with reasons and justifications showing why they were rejected.

6. DETAILED SCOPE OF WORK. The Detailed Scope of Work is contained in Annex A and B.

7. WORK TO BE ACCOMPLISHED.

7.1 Perform a Site Survey. The AE shall obtain all

necessary data to evaluate the possible ECOs by conducting a site survey. However, the AE is encouraged to use any data that may have been documented in a previous study if applicable. The AE shall document his site survey on forms developed for the survey, or standard forms, and submit these completed forms as part of the report. All test and/or measurement equipment shall be properly calibrated prior to its use.

7.2 Evaluate Possible and New ECOs. The AE shall analyze the possible ECOs listed in Annex A and B and shall analyze new ECOs discovered during the site survey (new ECOs shall be submitted to the Government and approved prior to their study). ECOs shall be analyzed in detail to determine their feasibility. Savings to Investment Ratios (SIRs) shall be determined using current ECIP guidance. The AE shall provide all data and calculations needed to support the recommended ECO. All assumptions and engineering equations shall be clearly stated. Calculations shall be prepared showing how all numbers (quantities, costs, benefits, etc.) in the ECO were derived. Calculations shall be an orderly step-by-step progression from the first assumption to the final number. Descriptions of the products, manufacturers catalog cuts, pertinent drawings and sketches shall also be included. A life cycle cost analysis summary sheet shall be prepared for each ECO and included as part of the supporting data.

7.3 Combine ECOs Into Recommended Projects. During the Interim Review Conference, as outlined in the following paragraph 7.4.1, the AE will be advised of the DPW's preferred packaging of recommended ECOs into projects for implementation. Some projects may be a combination of several ECOs, and others may contain only one. These projects will be evaluated and arranged as outlined in previous paragraphs 5.1, 5.2, and 5.3. Energy savings calculations shall take into account the synergistic effects of multiple ECOs within a project and the effects of one project upon another. The results of this effort will be reported in the Final Submittal per paragraph 7.4.2.

7.4 Submittals, Presentations and Reviews. The work accomplished shall be fully documented by a comprehensive report. The report shall have a table of contents and shall be indexed. Tabs and dividers shall clearly and distinctly divide sections, subsections, and appendices. All pages shall be numbered. Names of the persons primarily responsible for the project shall be included. The AE shall give a formal presentation of the interim submittal to installation, command, and other Government personnel. Slides or view graphs showing the results of the study to date shall be used during the presentation. During the presentation, the personnel in attendance shall be given ample opportunity to ask questions and discuss any changes deemed necessary to the study. Each comment presented at the review conference will be discussed and resolved or action items assigned. It is anticipated that the presentation and review conference will require approximately one working day. The presentation will be at the installation on the date agreeable to

the DPW, the AE and the Government's representative. The Contracting Officer may require a resubmittal of any document(s), if such document(s) is (are) not approved by the Contracting Officer due to inadequacy for the intended purpose.

7.4.1 Interim Submittal. An interim report shall be submitted for review after the field survey has been completed and an analysis has been performed on all of the ECOs. The report shall indicate the work which has been accomplished to date, illustrate the methods and justifications of the approaches taken and contain a plan of the work remaining to complete the study. Calculations showing energy and dollar savings, SIR, and simple payback period of all the ECOs shall be included. The results of the ECO analyses shall be summarized by lists as follows:

a. All ECOs eliminated from consideration shall be grouped into one listing with reasons for their elimination as discussed in paragraph 5.3.

b. All ECOs which were analyzed shall be grouped into two listings, recommended and non-recommended ECIP, each arranged in order of descending SIR. These lists may be subdivided by building or area as appropriate for the study.

The AE shall submit the Scope of Work and any modifications to the Scope of Work as an appendix to the report. A narrative summary describing the work and results to date shall be a part of this submittal. At the Interim Submittal and Review Conference, the Government's and AE's representatives shall coordinate with the DPW to provide the AE with direction for packaging or combining ECOs for programming purposes and also indicate the fiscal year for which the project or implementation documentation shall be prepared. The survey forms completed during this stage shall be submitted with this report. The survey forms only may be submitted in final form with this submittal. They should be clearly marked at the time of submission that they are to be retained. They shall be bound in a standard three-ring binder which will allow repeated disassembly and reassembly of the material contained within. The AE will be given a written approval of the Interim Submittal, after the Government's representative and DPW have received annotated comments and any revised documents from the Interim Submittal and Review Conference.

7.4.2 Final Submittal. The AE shall prepare and submit the final report when all sections of the report are 100% complete and all comments from the interim submittal have been resolved. The AE shall submit the Scope of Work for the study and any modifications to the Scope of Work as an appendix to the submittal. The report shall contain a narrative summary of conclusions and recommendations, together with all raw and supporting data, methods used, and sources of information. The report shall integrate all aspects of the study. The recommended projects, as determined in accordance with paragraph 5, shall be presented in order of priority by SIR. The lists of ECOs

specified in paragraph 7.4.1 shall also be included for continuity. The final report and all appendices shall be bound in standard three-ring binders which will allow repeated disassembly and reassembly. The final report shall be arranged to include:

a. An Executive Summary to give a brief overview of what was accomplished and the results of this study using graphs, tables and charts as much as possible (See Annex C for minimum requirements).

b. The narrative report describing the problem to be studied, the approach to be used, and the results of this study.

c. Documentation for the recommended projects (includes LCCA Summary Sheets).

d. Appendices to include as a minimum:

1) Energy cost development and backup data

2) Detailed calculations

3) Cost estimates

4) Computer printouts (where applicable)

5) Scope of Work

e. Project Documentation

ANNEX A

DETAILED SCOPE OF WORK - ELECTRICAL ENERGY DEMAND AND USAGE

1. The Architect-Engineer (A-E) shall furnish all services, material, labor, equipment, investigations, studies, superintendence and travel as required in connection with the below identified work in accordance with the general scope of work and this Detailed Scope of Work.

INSTALLATION	PROJECT TITLE
Pine Bluff Arsenal, AR	Electrical Energy Demand and Usage

2. The work and related data and services required in accordance with this Delivery Order shall be accomplished within the limitation of cost on subject project stated above and scope of work described in paragraph 3. The schedule for delivery of data to the Contracting Officer is in calendar days as follows:

	DATA	DELIVERY SCHEDULE
a.	Interim Submittal and Related Data or Studies	210 calendar days (after receipt of signed D.O)
b.	Final Submittal	90 calendar days (after approval of Interim Submittal)

3. The items of work included in this delivery order shall be in accordance with criteria furnished at the Prestudy Conference held at Pine Bluff Arsenal, 12/13/95. The services to be provided shall include, but not be limited to, the following:

a. Items of Work. The scope of the work includes survey and evaluation of ECOs for electrical energy demand and usage for motors greater than 50 horsepower in the following buildings:

BLDG NO.	NAME OF BUILDING	QTY	SURVEY TO INCLUDE MOTOR FOR	ASSIGNED TO	SQ FT
~~31-630~~	~~Fill & Press~~	~~1~~	~~Compressor~~	~~Prod/Dir/OTS~~	~~12,969~~
32-060	Boiler & Compressor House	2	Compressor	BGU&PS Div	2,875
~~32-620~~	~~Colored Smoke Mix~~	~~1~~	~~Compressor~~	~~Prod Div~~	~~7,167~~
33-060	Boiler/Compressor	2	Compressor	BGU&PS Div	2,875
~~33-530~~	~~Fill & Press~~	~~1~~	~~Compressor~~	~~Prod Div~~	~~13,808~~
34-140	Boiler/Compressor	2	Compressor	BGU&PS Div	5,050
34-196	Evap S & D Bldg	2	Fan	DMO	4,600
42-010	Water Well No. 1	1	Water Pump	BGU&PS Div	176
42-030	Water Well No. 3	1	Water Pump	BGU&PS Div	176
42-210	Pump and Filter	4	Water Pumps	BGU&PS Div	3,816

~~42-960~~	~~Grenade Test Building~~	~~1~~	~~Compressor~~	~~DMMD~~	~~2,772~~
42-979	Afterburner Control Bldg	1	Fan	DMMD	240

b. Government Furnished Items.

(1) As-built drawings, as available.

(2) Energy consumption data (as available) and related documents.

(3) Guide Specifications and standard motor loads and equipment details as requested.

(4) Access to facilities for the field investigation.

(5) Final reports of previously completed studies performed under the Energy Engineering Analysis Program (EEAP).

(6) Latest copies of other energy studies performed (Energy Awareness Program).

(7) ETLs 1110-3-254, Use of Electric Power for Comfort Space Heating (if applicable), and 1110-3-282, Energy Conservation.

(8) Architectural and Engineering Instructions.

(9) Energy Conservation Investment Program (ECIP) Guidance, dated 10 Jan 1994.

(10) TM 5-785, Engineering Weather Data, TM 5-800-2, General Criteria Preparation of Cost Estimates.

(11) AR 415-15, 1 Jan 84, Military Construction, Army (MCA) Program Development

(12) The latest MCP Index.

c. Special Requirements.

(1) Direct Distribution of Submittals: The AE shall make direct distribution of correspondence, minutes, report submittals, and responses to comments as indicated by the following schedule:

AGENCY	CORRESPONDENCE	EXECUTIVE SUMMARIES	REPORTS	FIELD NOTES
Commander U.S. Army, Pine Bluff Arsenal Attn: SMCPB-EHN (Ms. Rimmer) 10020 Kabrich Circle Pine Bluff, AR, 71602-9500	1	5I/5F*	5I/5F*	1**
Commander U.S. AMC Installation and Service Activity Attn: AMXEN-C (Mr. Nache) Rock Island, IL, 61299-7190	-	1	1	-
Commander U.S. Army Engineer District, Little Rock Attn: CESWL-ED-DM (Ms. Hartman) 700 West Capitol/P.O. Box 867 Little Rock, AR, 72203-0867	1	1	1	1**
Commander U.S. Army Engineer Division, Southwest Attn: CESWD-PP-MM (Mr. West) 1114 Commerce Street Dallas, TX, 75242-0216	-	1	1	-
Commander U.S. Army Engineer District, Mobile Attn: CESAM-EN-DM (Mr. Battaglia) P. O. Box 2288 Mobile, AL, 36628	1	1	1	-
Commander U.S. Army Corps of Engineers Attn: CEMP-ET (Mr. Gentil) 20 Massachusetts Avenue NW Washington, DC, 20314-1000	-	1	-	-
Commander U.S. Army Logistics Evaluation Agency Attn: LOEA-PL (Mr. Keath) New Cumberland Army Depot New Cumberland, PA, 17070-5007	-	1	-	-

* 5I/5F indicates five (5) copies at interim submittal, five (5) copies at final submittal.

** Field notes submitted in final form at interim submittal.

(2) Security Requirements. The AE shall follow the requirements as stated in Annex E while conducting site surveys.

4. Energy Conservation Opportunities (ECOs). The following is a list of possible ECOs to be investigated in the electrical energy demand and usage study.

~~a. Load Shedding~~

~~(1) Isolate energy demand contributions.~~

~~(2) Reduce contracted demand limit.~~

b. Load Reduction

~~(1) Determine which loads may be reduced or dropped.~~

~~(2) Establish present energy usage and costs.~~

~~(3) Look at annual increase in energy cost associated with the usage.~~

(4) Replace existing motors with more energy efficient motors.

~~(5) Provide adjustable speed drives (ASD's) to reduce motor electrical energy usage.~~

~~c. Load Shifting~~

~~(1) Use other ways of providing power to reduce demand charge and energy usage charge.~~

5. Designated coordinators. The government's representative for this project is Exa Hartman. The DPW Energy coordinator, Nancy Rimmer, will serve as administrative coordinator. The DPW technical coordinator is Ralph Rimmer.

6. Analysis programs. A computer program titled Life Cycle Costing in Design (LCCID) is available from the BLAST Support Office in Urbana, Illinois for a nominal fee. This computer program can be used for performing the economic calculations for ECIP and non-ECIP ECOs. The AE is encouraged to obtain and use this computer program. The BLAST Support Office can be contacted at 144 Mechanical Engineering Building, 1206 West Green Street, Urbana, Illinois 61801. The telephone number is (217) 333-3977 or (800) 842-5278.

7. Programming year for projects meeting ECIP criteria. All projects meeting the ECIP criteria shall be programmed for FY97, others such as ECAM and Low Cost/No Cost shall be programmed as directed by the DPW.

ANNEX B

DETAILED SCOPE OF WORK - HEATING AND COMPRESSED AIR

1. The Architect-Engineer (A-E) shall furnish all services, material, labor, equipment, investigations, studies, superintendence and travel as required in connection with the below identified work in accordance with the general scope of work and this Detailed Scope of Work.

INSTALLATION	PROJECT TITLE
Pine Bluff Arsenal, AR	Heating

2. The work and related data and services required in accordance with this Delivery Order shall be accomplished within the limitation of cost on subject project stated above and scope of work described in paragraph 3. The schedule for delivery of data to the Contracting Officer and Government's representative is in calendar days as follows:

DATA	DELIVERY SCHEDULE
a. Interim Submittal and Related Data or Studies	210 calendar days (after receipt of signed D.O)
b. Final Submittal	90 calendar days (after approval of Interim Submittal)

3. The items of work included in this delivery order shall be in accordance with criteria furnished at the Prestudy Conference held at Pine Bluff Arsenal, 12/13/95. The services to be provided shall include, but not be limited to, the following:

a. Items of Work. The scope of the work includes survey and evaluation of ECOs for energy conservation opportunities for heating and compressed air systems in the following buildings:

(1) Building # ~~33-530, 32-620, 31-620, 31-630~~, 32-060, 33-060, 34-140, 42-960, 44-120.

b. Government Furnished Items.

(1) As-built drawings, as available.

(2) Energy consumption data (as available) and related documents.

(3) Guide Specifications and standard motor loads and

equipment details as requested.

(4) Access to facilities for the field investigation.

(5) Final reports of previously completed studies performed under the Energy Engineering Analysis Program (EEAP).

(6) Latest copies of other energy studies performed (Energy Awareness Program).

(7) ETLs 1110-3-254, Use of Electric Power for Comfort Space Heating (if applicable), and 1110-3-282, Energy Conservation.

(8) Architectural and Engineering Instructions.

(9) Energy Conservation Investment Program (ECIP) Guidance, dated 10 Jan 1994.

(10) TM 5-785, Engineering Weather Data, TM 5-800-2, General Criteria Preparation of Cost Estimates.

(11) AR 415-15, 1 Jan 84, Military Construction, Army (MCA) Program Development

(12) The latest MCP Index.

(13) Sample 1391 and PDB (see enclosures).

c. Special Requirements.

(1) Direct Distribution of Submittals: The AE shall make direct distribution of correspondence, minutes, report submittals, and responses to comments as indicated by the following schedule:

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Commander U.S. AMC Installation and Service Activity Attn: AMXEN-C (Mr. Nache) Rock Island, IL 612999-7190	-	1	1	-
Commander U.S. Army Engineer District, Little Rock Attn: CESWL-ED-DM (Mr. Martinez) 700 West Capitol/P.O. Box 867 Little Rock, AR, 72203-0867	1	1	1	1**
Commander U.S. Army Engineer Division, Southwest Attn: CESWD-PP-MM (Mr. West) 1114 Commerce Street Dallas, TX, 75242-0216	-	1	1	-
Commander U.S. Army Engineer District, Mobile Attn: CESAM-EN-CM (Mr. Battaglia) P. O. Box 2288 Mobile, AL, 36628	1	1	1	-
Commander U.S. Army Corps of Engineers Attn: CEMP-ET (Mr. Gentil) 20 Massachusetts Avenue NW Washington, DC, 20314-1000	-	1	-	-
Commander U.S. Army Logistics Evaluation Agency Attn: LOEA-PL (Mr. Keath) New Cumberland Army Depot New Cumberland, PA, 17070-5007	-	1	-	-

* 5I/5F indicates five (5) copies at interim submittal, five (5) copies at final submittal.

** Field notes submitted in final form at interim submittal.

(2) Security Requirements. The AE shall follow the requirements as stated in Annex E while conducting site surveys.

4. Energy Conservation Opportunities (ECOs). The following is a list of possible ECOs to be investigated in the heating and compressed air study.

a. There are two ageing boilers in Bldg. 33-060 (Main Steam Plant No. 3) which feed into the main steam grid. The history of these boilers is as follows. They were installed in 1942 and were rated @ 311 Horsepower each, Babcox and Wilcox, Natural Draft. During the Vietnam era demand increased, forced draft burners were added to the boilers allowing them to operate @ more than twice their rated capacity. However, the radiant surface of the boilers was not increased, baffles were not installed, and

consequently when the boilers are fired to their operating peak of 25,000 lb per hour (more than twice the original rated HP) the stack temperature increases to 800-1000 deg F, and the efficiency drops drastically. Current operating efficiency is approximately 60 to 70 percent when operating @ lower lb per hour steam output than the 25,000 lb per hour peak. Test these boilers for efficiency and investigate the life cycle cost of installing modern more efficient fire tube boilers possibly w/ O2 trim, turbulators, or economizer to replace the aforementioned boilers. The new boilers can be placed on a new concrete pad and sheet metal enclosure behind the building and the existing boilers remain as standby for maintenance. If less expensive, the old multistory boilers can be dismantled, removed and the same space utilized for the new boilers. Preliminary indications are that new boilers with a 20 % increase in efficiency, could possibly yield $60,000 per year or more in fuel savings and maintenance savings for the Life Cycle Cost program for this Bldg alone.

b. The two boilers in building 42-960 are 1380 lb/hr @150 psi. Test these boilers for efficiency and investigate the life cycle cost of installing more efficient fire tube boilers w/ O2 trim, turbulators, or economizers to replace the aforementioned boilers."

c. The three boilers in building 34-140 were similar to those in bldg 32-060 with the exception that these boilers were rated @ 275 HP in 1942 and increased to 20,000 lb per hour each when natural draft was changed to forced draft as described for bldg 32-060 in Paragraph 4a above. There is an ECIP project currently in progress to construct a new boiler house with two new 350 horsepower boilers. The new boiler house will be located north of Building 34-120 in the White Phosphorus Area. The new boilers will be connected to the existing high pressure steam main. The investigation to be conducted for theseexisting boilers and the Life Cycle Cost Study for these boilers is similar in scope to that for Bldg. 32-060 in 4a above. If the study should conclude that replacing the existing boilers with new boilers is not economically feasible, then study adding a deareator for the existing boilers. A deareator must be added and included in the Life Cycle Cost Study if new boilers are considered.

d. There are two boilers in bldg. 44-120, one is a Clever Brooks CBH -200-100 rated for 4,184,000 BTU/hr @ 150 psi and the other is a 26 year old boiler rated for approx 100 HP @ 150 psi. Test these boilers for efficiency and investigate the life cycle cost of installing more efficient fire tube boilers w/O2 trim, turbulators, or economizers to replace the aforementioned boilers. Also study the installation of O2 trim and turbulators in the first (Clever Brooks) boiler as an alternative to replacing this boiler.

e. There are currently two surplus boilers stored in the vicinity of building 34-140. These boilers are to be installed and put into service under a separate contract by the Pine Bluff Arsenal. Study the economic potential savings and life cycle

cost of adding an economizer to these boilers.

f. ~~There are presently six compressors used to supply the production areas located two each in Bldgs 32-060, 33-060, & 34-140. The Pine Bluff Arsenal has two Gardner Denver compressors Ser. No. A23794&5 in storage. Investigate the savings and life cycle cost of replacing two of the existing compressors with these new ones and/or adding these two compressors on line with the existing compressors.~~ Determine the energy use and cost associated with leaks from the existing high pressure steam distribution system. Provide calculations, cost estimate and economic analysis for repairing or replacing the existing above ground steam distribution system between the boiler houses and the end use buildings.

5. Designated coordinators. The government's representative for this project is Joe Martinez. The DPW Energy coordinator, Nancy Rimmer, will serve as administrative coordinator. The DPW technical coordinator is Kurt Williams.

6. The efficiency of the boilers shall be determined by field testing. The AE shall provide equipment and perform the tests to establish the efficiency of the boilers. The tests are intended to determined the efficiency of the boilers as they are actually being operated. The combustion efficiency may be determined from an Orsat analysis of the flue gases. Based on the results of the tests, any indicated areas of improvement or equipment modifications shall be fully analyzed. The analysis shall evaluate boiler loading profiles versus boiler capacity and shall establish boiler efficiency and boiler operating baselines. The boiler and ECO analyses shall be based on the assumption that the existing high pressure steam distribution system will be repaired or replaced, and the current losses due to leaks in the steam piping system will be substantially reduced. The Government will furnish fuel, utilities and other consumables and provide personnel as needed to operate the boilers during the test. All test and measurement equipment shall be properly calibrated prior to its use.

7. Analysis programs. A computer program titled Life Cycle Costing in Design (LCCID) is available from the BLAST Support Office in Urbana, Illinois for a nominal fee. This computer program can be used for performing the economic calculations for ECIP and non-ECIP ECOs. The AE is encouraged to obtain and use this computer program. The BLAST Support Office can be contacted at 144 Mechanical Engineering Building, 1206 West Green Street, Urbana, Illinois 61801. The telephone number is (217) 333-3977 or (800) 842-5278.

8. Programming year for projects meeting ECIP criteria. All projects meeting the ECIP criteria shall be programmed for FY97, others such as ECAM and Low Cost/No Cost shall be programmed as directed by the DPW.

ANNEX C

EXECUTIVE SUMMARY GUIDELINE

1. Introduction.

2. Building Data (types, number of similar buildings, sizes, etc.)

3. Present Energy Consumption of Buildings or Systems Studied.

   o Total Annual Energy Used.

   o Source Energy Consumption.

   Electricity - KWH, Dollars, BTU

4. Reevaluated Projects Results.

5. Energy Conservation Analysis.

   o ECOs Investigated.

   o ECOs Recommended.

   o ECOs Rejected. (Provide economics or reasons)

   o ECIP Projects Developed. (Provide list)*

   o Non-ECIP Projects. (Provide list)*

   o Operational or Policy Change Recommendations.

* Include the following data from the life cycle cost analysis summary sheet: the cost (construction plus SIOH), the annual energy savings (type and amount), the annual dollar savings, the SIR, the simple payback period and the analysis date.

6. Energy and Cost Savings.

   o Total Potential Energy and Cost Savings.

   o Percentage of Energy Conserved.

   o Energy Use and Cost Before and After the Energy Conservation Opportunities are Implemented.

ANNEX D

REQUIRED PROJECT DOCUMENTATION

To facilitate ECIP project approval, the following data shall be provided:

Document (Data)

1. Administrative Package

b. Annotated General Site Plan

c. Facilities Requirements Sketch

d. DD Form 1391
SECTION 1 (HEADER)
SECTION 2 (COST DATA)
SECTION 3 (JUSTIFICATION SUMMARY)
SECTION 4 (REQUIREMENTS/APPROVALS)
SECTION 5 (NOT USED)
SECTION 6 (DESIGN DATA/COSTS)
SECTION 7 (GENERAL)
SECTION 8 (EXISTING/DEMOLITION)
SECTION 9 (INVENTORY IMPACTS)
SECTION 10 (DEFICIENCY)
SECTION 11 (ECONOMIC ANALYSIS)
SECTION 12 (CONSTRUCTION CRITERIA)
SECTION 13 (EQUIPMENT PROGRAM)
SECTION 14 (NOT USED)
SECTION 15 (ENVIRONMENTAL)
SECTION 16 (FLOOD)
SECTION 17 (COMMUNICATIONS)
SECTION 18 (HISTORICAL)
SECTION 19 (ENERGY)
SECTION 20 (HANDICAPPED)
SECTION 21 (NEW START)
SECTION 22 (SECURITY)
SECTION 23 (MISCELLANEOUS)

2. Technical Package

a. Detail Site Plan
b. Building Area Plan
c. Single Line Floor Plan
d. PDB 1
e. PDB 2

To facilitate ECIP project approval, the following 1391 additional data shall be provided:

a. In title block clearly identify projects as "ECIP." (Section 1H).

b. Complete description of each item of work to be accomplished including quantity, square footage, etc. (Section 3A).

c. A comprehensive list of buildings, zones, or areas including building numbers, square foot floor area, designated temporary or permanent, and usage (administration, patient treatment, etc.). (Section 8).

d. List references, and assumptions, and provide calculations to support dollar and energy savings, and indicate any added costs. (Section 11).

(1) If a specific building, zone, or area is used for sample calculations, identify building, zone or area, category, orientation, square footage, floor area, window and wall area for each exposure. (Section 12).

(2) Identify weather data source. (Section 12).

(3) Identify infiltration assumptions before and after improvements. (Section 12).

(4) Include source of expertise and demonstrate savings claimed. Identify any special or critical environmental conditions such as pressure relationships, exhaust or outside air quantities, temperatures, humidity, etc. (Section 12).

e. An ECIP life cycle cost analysis summary sheet as shown in the ECIP Guidance shall be provided for the complete project and for each discrete part included in the project. The SIR is applicable to all segments of the project. Supporting documentation consisting of basic engineering and economic calculations showing how savings were determined shall be included. (Section 11).

f. The DD Form 1391 face sheet shall include, for the complete project, the annual dollar and KW-HR savings, SIR, simple amortization period and a statement attesting that all buildings and retrofit actions will be in active use throughout the amortization period. (Section 3G).

g. The calendar year in which the cost was calculated shall be clearly shown on the DD Form 1391. (Section 1D).

h. Nonappropriated funded facilities will not be included in an ECIP project without an accompanying statement certifying that utility costs are not reimbursable.

i. Any requirements required by ECIP guidance dated 4

November 1992 and any revisions thereto. Note that costs/savings that are not escalated are to be used in the economic analyses.

j. The five digit category number for all ECIP projects except for Family Housing is 80000. The category code number for Family Housing projects is 71100.

ANNEX E

PINE BLUFF ARSENAL - SECURITY REQUIREMENTS

1.1 The work to be accomplished under this contract is located within the Pine Bluff Arsenal. Below are special security requirements of the Pine Bluff Arsenal Security Office and shall be applicable to all contracts within the Pine Bluff Arsenal.

1.1.1 Notice of Magistrate System

In accordance with the Arkansas State statutes, the Federal Magistrate System has been enacted at Pine Bluff Arsenal. Persons issued a citation on Pine Bluff Arsenal are subject to fines and may be required to appear before a Federal Magistrate in Little Rock, AR.

1.1.2 Security Awareness

Pine Bluff Arsenal is a controlled access installation. Specific security requirements as they apply to the project site will be noted during a prestudy conference. The Contractor will exercise care to prevent unauthorized intrusion by locking gates, closing and locking doors/windows, and performing similar actions. In the event that a breach of security occurs notwithstanding the Contractor's efforts to prevent it, he shall immediately notify the Pine Bluff Arsenal Security Police (543-3505), reporting the occurrence and explaining the nature of the violation.

1.1.3 Security Requirements For Contractors

1.1.3.1 Specific Requirements

All Contractors working at the Pine Bluff Arsenal shall comply with security rules and regulations generally applicable to all persons entering the installation. In addition, specific requirements applicable to Contractor personnel are as follows:

a. Contractors will register vehicles, privately owned vehicle (POV) or otherwise, used in the performance of contract with the Security Office. An affidavit will be signed by the Contractor stating that he has and will continue to maintain liability insurance on all vehicles in an amount not lower than the minimum limits prescribed by the financial responsibility or the compulsory law of the State of Arkansas.

b. All Contractor or subcontractor vehicles used on Pine Bluff Arsenal must have a company sign prominently displayed on each side of the vehicle, if work is being performed in production area. These signs may be permanently affixed to the vehicle or may be the magnetic type.

c. All Contractor personnel will be required to be badged prior to the beginning of any Contractor services as follows:

(i) Contractors performing services within non-sensitive areas of the installation will be issued a non-photographic type ID badge if the contract does not exceed 21 calendar days. Employee need not be present.

(ii) Contractors performing services within non-sensitive areas of the installation will be issued a photographic type ID badge if the contract exceeds 21 calendar days. Contractor employee must be present at the Security Office to be issued the badge.

(iii) Contractors performing services within sensitive areas of the installation will be issued a non-photographic type ID badge and visitor pass if the contract does not exceed 21 calendar days. Contractor employees must be present at the Security Office to be issued the badge and pass. Badge exchange will be required by all personnel at the entrance to areas where required.

(iv) Contractors performing services within sensitive areas of the installation will be issued a photographic type ID badge if the contract exceeds 21 calendar days. Contractor employees must be present at the Security Office to be issued the badge. Badge exchange is required by all personnel at the entrance to areas where required.

(v) If non-photographic type badges are used, the Contractor or subcontractor will furnish the Security Office with the names of all Contractor employees to whom such badges are issued by number. This list of names will remain current at all times. If visitor passes are issued with non-photographic type badges, the procedures in paragraph (vi) below apply.

(vi) If photographic type badges are issued to Contractor employees, the Security Office will maintain a list of all badges issued by name, number, etc. However, the Contractor will insure that all employees report to the Security Office for issuance of photographic type ID badges or visitor passes.

(vii) The Contractor or subcontractor will insure that all ID badges of any type are returned to the Security Office upon termination of the contract or termination of any individual employee. Contractors will also be responsible to insure that all vehicle registrations are cancelled and vehicle decals are removed and returned to the Security Office.

(viii) Contractors or subcontractors will be required to reimburse the U.S. Government in the amount of $2.00 for replacement of ID badges lost or not returned to the Security Office upon termination of contract.

(ix) Contractor employees arriving at any gate or area improperly badged or without an Arsenal ID badge will be denied entrance until proper identification or badging has been accomplished.

(x) Contractor and subcontractor personnel performing services within exclusion areas or highly sensitive areas will be required to be escorted by an appropriately cleared and authorized individual at all times while in such areas.

1.1.3.2 Work In Exclusion Area

a. Some of the contract work may be in the BREA. All personnel engaged in work in the Conventional Limited Area, Building 34-111, Hanlon Road Igloo Area and Bond Road Exclusion Area (BREA) shall be required to carry properly fitted protective mask on their person at all times. Personnel must be clean shaven to be properly fitted with the protective mask or with a respirator. Personnel working within Public Access Exclusion Areas (all areas north and west of Atkisson Road) shall have protective mask immediately available. Protective masks will be furnished, fitted and periodically inspected by the Government. Protective masks will be issued to the Contractor on a receipt basis for each employee under his supervision. Masks must be returned to the Government upon termination of the contract. The Contractor shall not take any masks off the Pine Bluff Arsenal. The Contractor shall provide a waterproof box with lock for storage of the masks during non-working hours. The box shall be kept at a site approved by the Contracting Officer. Masks must be returned to the Government, immediately, upon termination or release of any employee.

b. Individual fitting of mask takes approximately 20 minutes. In addition, masks must be inspected semi-annually and annually, based on date of last inspection. Masks must be turned in for inspection when requested. Every two weeks, the Arsenal will publish a list of masks due or over due for inspection and furnish same to Contracting Officer. This list will be provided to the Contractor for action.

Mask inspection takes 1-2 days but the individual need not be present. The Contractor will be notified when masks are ready for re-issue and re-fitting.

c. If mask is more than 8 weeks overdue, the Contracting Officer may take any reasonable action to ensure that the Government's interest in the mask is protected and that the safety of Contractor personnel is ensured.

d. Such other safety measures as the Contracting Officer may determine to be reasonable and necessary for the protection of personnel and property will be enforced.

e. Contractor personnel working in restricted areas shall have an additional safety briefing, a blood test, and a 288 card before starting work. These areas include, but are not limited to Bond Road Exclusion Area (BREA) and Building 34-111. The general safety briefing takes approximately 45 minutes to complete and the safety briefing for work in the BREA takes approximately 3 hours. A waiting period of approximately 10 days is required between the blood test and entering the BREA.

f. Escorts are required in the BREA. The Contractor must give 48 hours advance notice to the Contracting Officer who in-turn will contact the escort agency. There is no set maximum number of workers that an individual escort can accompany at one time. All costs in connection with furnishing escorts for this contract will be borne by the Government.

1.1.3.3 Encounter of Irritants

In chemical manufacturing and storage areas, there exists a possibility of encounter with irritants by contract personnel. These areas will be identified to the Contractor prior to the start of the contract. Instructions and guidance will be furnished to the Contractor by the Contracting Officer, the Installation Safety Office and the Director of Law Enforcement and Security.

1.1.4 Employee Identification

The Contractor shall be responsible for providing positive identification of employees as required by the Security Office at Pine Bluff Arsenal. Prior to beginning work or receiving a notice to proceed, the Contractor shall identify with the Procurement and Security Offices points of contact who shall be responsible for identifying employees, subcontractors, vendors and delivery personnel. One identified point of contact shall personally accompany any Contractor personnel, subcontractors, vendors or delivery personnel to be badged to the Security Office. Employees or other personnel arriving without an identification point of contact will not be badged. Any delays caused by improper

identification of employees shall be at the Contractor's expense and no time extension shall be allowed for such delays.

1.1.5 Notice To Contractors

All personnel are hereby notified that any Non-U.S. Citizen must meet the provisions of AR 380-25 prior to being permitted on Pine Bluff Arsenal.

1.1.5.1 Authorization for Alien

All Contractor personnel will be required to produce proof of citizenship prior to being badged. If Contractor's employees are aliens, the Contractor will submit a request through the COR, through the Security Office to the Commander, asking for authorization for the resident alien to work on Pine Bluff Arsenal. The request should include:

Name:
Resident Alien No.:
Country of citizenship:

1.1.5.2 Alien Escort

Upon authorization, resident aliens will be issued an "Escort Required" badge, meaning a U.S. Citizen must escort the individual while working on Pine Bluff Arsenal. Failure to do so could mean the employee will be escorted off-post and barred from re-entry.

1.1.5.3 Badging of Citizens of Communist Block Countries

Requests for badging of Contractor personnel who are citizens of communist block countries will be submitted to Contracting Officer's Representative for processing through the local Security Office to the Assistant Chief of Staff Intelligence, HQ DO (DAMI-FL) Washington, DC 20310 and shall include:

Full Name:
Date of birth:
Official Title/Position:
Nationality:
Security Clearance: (If Individual Has One)
Firm Name and Address:
VISA/Passport/Orders No. or Serial No.:
Dates of Requested Access:
Social Security Number: (If Individual Has One)
Sponsor: (Will Be Provided by Procurement Office)
Name of Activity: (Pine Bluff Arsenal)
Purpose: (Justification of Reason for Requested Entry to Pine Bluff Arsenal).

1.1.6 Not Used

1.1.7 Notice of Possible Delays

During the time a Contractor is working on the Arsenal, he may, from time to time, be working in an area where munitions test exercises are conducted; delays may occur. These delays may involve Contractor personnel being withdrawn from an area or being denied access for a period of time. The length of time and frequency of these delays will be held to a minimum. Delays will be encountered when entering the BREA (Bond Road Exclusion Area).

1.2 PINE BLUFF ARSENAL - USE OF CAMERAS

1.2.1 Policy

Pine Bluff Arsenal has a policy restricting use of cameras in order to ensure that National Security is not jeopardized. This policy covers any level of Contractor, subcontractor, supplier, employee, or consultant.

1.2.2 Definitions

The terms "camera", "picture", and "photography" or any derivative used below refer to any medium which can record exact or near-exact images (stills, video, movies, etc).

1.2.3 Camera Pass

All cameras shall be registered with the PBA Provost Marshal's Office (PMO) and with the Contracting Officer. Each Contractor-owned camera shall be assigned to a designated photographer who will be the only one authorized to use it. Once registered, the camera will have a camera pass issued for it. The camera pass shall be with the camera at all times.

1.2.4 Photographers

Only designated photographers will be allowed to take pictures using cameras registered as above. The photographer shall be responsible for ensuring that the recorded frame does not contain any sensitive information as defined in paragraph: Photographic Restrictions below. Photographers' names will be placed on lists maintained by both the Contracting Officer and the PBA PMO. Only two photographers will be allowed for this contract.

1.2.5 Photographic Restrictions Agreement Form

Prior to having their names put on the list, potential photographers will be briefed on photographic restrictions on PBA. Each photographer will sign the following agreement form, copies of which are to be returned to the Contracting Officer and the PBA PMO.

STATEMENT OF UNDERSTANDING
PHOTOGRAPHIC RESTRICTIONS ON PBA

1. I, ______________________________, am a designated photographer for

____.

2. I understand that there are certain restrictions on taking pictures on Pine Bluff Arsenal. Specifically, pictures are not to be taken of the following:

a. Vehicle convoys and convoy-like movements.

b. PBA vehicles (except for the express reason of documenting accidents involving these vehicles and then only after receiving permission from the PMO to take the picture).

c. Emergency Ordnance Disposal (EOD) teams, equipment, procedures, or when they are in the performance of their duties.

d. Sensitive sites and facilities (controlled, limited, and restricted), including -- but not limited to -- the BZ Plant, the Binary I Production Facility, other production facilities, storage facilities, etc. and similar type facilities.

e. Sensitive items, facilities (controlled, limited, and restricted), or activities as designated by the Commander, PBA, or an authorized representative.

3. I will only take pictures to record study items subject to the above limitations and within limits of the designated area of our contract.

4. I will take all pictures in such direction as necessary to prevent inadvertent inclusion of sensitive sites, facilities, and activities as mentioned above.

5. I will not allow others to use my camera equipment.

6. I understand taking unauthorized pictures will result in the following:

a. Film and equipment will be confiscated with NO WARNING.

b. I will be <u>immediately</u> escorted off the Arsenal by PBA Security personnel, have my badge confiscated, and be denied further access to the installation. NO WARNING WILL BE GIVEN.

c. I may also be subject to penalties and disciplinary actions pursuant to federal laws, codes, or regulations.

______________________	______________________	__________
(printed name)	(signature)	(date)

1.2.6 Photographic Restrictions

Pictures are not to be taken of the following items:

(1) Vehicle convoys and convoy-like movements.

(2) PBA vehicles (except for the express reason of documenting accidents involving these vehicles and then only after receiving permission from the PMO to take the picture).

(3) Emergency Ordnance Disposal (EOD) teams, equipment, procedures, or when they are in the performance of their duties.

(4) Sensitive sites and facilities (controlled, limited, and restricted), including -- but not limited to -- the BZ Plant, the Binary I Production Facility, other production facilities, storage facilities, etc. and similar type facilities.

(5) Other items, facilities, or activities as designated by the Commander, PBA, or his authorized representatives.

1.2.7 Use of Cameras

The cameras shall be used only to record study items subject to the limitations and exceptions stated herein, and within the limits of the designated area of the contract. Pictures shall be taken in such direction as necessary to prevent inadvertent inclusion of sensitive sites, facilities, and activities as mentioned above.

1.2.8 Exceptions

At the request of the Government (EOD, Security, etc.) and AFTER receiving approval of the PBA Provost Marshal, pictures may be taken of selected sensitive sites or activities as an exception to the above. When so authorized, a representative of the Contracting Officer shall personally accompany the photographer. The film to be used will be issued by the Arsenal. The exposed film will be immediately turned over to the PMO for development and review and turned over to the requested agency after appropriate security checks have been made.

1.2.9 Actions for Unauthorized Pictures

Unauthorized pictures are those taken in violation of the above paragraphs. Specifically, unauthorized pictures are those taken with unauthorized equipment, by an unauthorized person, or of an unauthorized activity or facility. Taking of unauthorized pictures will result in the following actions being taken:

(1) Film and equipment will be confiscated. NO WARNINGS WILL BE GIVEN. Film may not be exposed until after a determination has been made concerning disciplinary action or federal charges.

(2) The individual will be immediately escorted off the Arsenal by PBA Security personnel, have his badge confiscated, and be denied further access to the installation. NO WARNINGS WILL BE GIVEN.

(3) At the discretion of the Contracting Officer, the Commander, PBA, or other Government agencies, violators may also be subject to penalties and disciplinary actions pursuant to federal laws, codes, or regulations.

AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT

1. CONTRACT ID CODE

PAGE 1 OF 1 PAGES

2. AMENDMENT/MODIFICATION NO.	3. EFFECTIVE DATE	4. REQUISITION/PURCHASE REQ. NO.	5. PROJECT NO. (If applicable)
01	96 Feb 13		

6. ISSUED BY CODE W41XDE

US ARMY ENGINEER DISTRICT, MOBILE
P.O. BOX 2288
MOBILE, ALABAMA 36628-0001

7. ADMINISTERED BY (If other than Item 6) CODE

US ARMY ENGINEER DISTRICT, LITTLE ROCK
P.O. BOX 867
LITTLE ROCK, AR 72203-0867

8. NAME AND ADDRESS OF CONTRACTOR (No., street, county, State and ZIP code)

REYNOLDS, SMITH AND HILLS, INC.
4651 SALISBURY ROAD
JACKSONVILLE, FLORIDA 32256

CODE | FACILITY CODE

(X) 9A. AMENDMENT OF SOLICITATION NO.

9B. DATED (SEE ITEM 11)

X 10A. MODIFICATION OF CONTRACT/ORDER NO.
Delivery Order No. 0004
Contract DACA01-94-0038

10B. DATED (SEE ITEM 13)
95 SEP 12

11. THIS ITEM ONLY APPLIES TO AMENDMENTS OF SOLICITATIONS

☐ The above numbered solicitation is amended as set forth in Item 14. The hour and date specified for receipt of Offers ☐ is extended, ☐ is not extended.
Offers must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation or as amended, by one of the following methods:
(a) By completing Items 8 and 15, and returning ______ copies of the amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGEMENT TO BE RECEIVED AT THE PLACE DESIGNATED FOR THE RECEIPT OF OFFERS PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided each telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

12. ACCOUNTING AND APPROPRIATION DATA (If required)

2152050 08-8071 P7000 S34066 RA521250001B400 $92,554.00 TOTAL DIRECT CITE ORG: NT

13. THIS ITEM APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS, IT MODIFIES THE CONTRACT/ORDER NO. AS DESCRIBED IN ITEM 14.

(X)	
	A. THIS CHANGE ORDER IS ISSUED PURSUANT TO: (Specify authority) THE CHANGES SET FORTH IN ITEM 14 ARE MADE IN THE CONTRACT ORDER NO. IN ITEM 10A.
	B. THE ABOVE NUMBERED CONTRACT/ORDER IS MODIFIED TO REFLECT ADMINISTRATIVE CHANGES (such as changes in paying office, appropriation date, etc.) SET FORTH IN ITEM 14, PURSUANT TO AUTHORITY OF FAR 43.103(b).
X	C. THIS SUPPLEMENTAL AGREEMENT IS ENTERED INTO PURSUANT TO AUTHORITY OF: Contract Clause No. 57, CHANGES--FIXED-PRICE (ALTERNATE III)
	D. OTHER (Specify type of modification and authority)

E. IMPORTANT: Contractor ☐ is not, ☒ is required to sign this document and return origin copies to the issuing office.

14. DESCRIPTION OF AMENDMENT/MODIFICATION (Organized by UCF section headings, including solicitation/contract subject matter where feasible.)

This no cost Modification is issued to modify Energy Conservation Opportunities (ECO's) in the Scope of Work due to conflicts with on-going projects at PBA. Paragraph 3.a. in Annex and paragraph 4.a., b., c., d., and e. in Annex B of the Revised Scope of Work (Encl 1) have been revised to reflect these changes.

Except as provided herein, all terms and conditions of the document referenced in Item 9A or 10A, as heretofore changed, remains unchanged and in full force and effect.

15A. NAME AND TITLE OF SIGNER (Type or print)		16A. NAME AND TITLE OF CONTRACTING OFFICER (Type or print)	
Carlos S. Warren, PhD, PE , Project Manager		Gene L. Curtis	
15B. CONTRACTOR/OFFEROR [signature] (Signature of person authorized to sign)	15C. DATE SIGNED 2/2/96	16B. UNITED STATES OF AMERICA BY Gene L Curtis (Signature of Contracting Officer)	16C. DATE SIGNED 96 Feb 13

DEPARTMENT OF THE ARMY
LITTLE ROCK DISTRICT, CORPS OF ENGINEERS
POST OFFICE BOX 867
LITTLE ROCK, ARKANSAS 72203-0867

REPLY TO
ATTENTION OF

CESWL-ED-DM

18 January 1996

MEMORANDUM FOR Commander, U.S. Army Engineer District, Mobile, ATTN: CESAM-EN-DM (Mr. Tony Battaglia), 109 St. Joseph Street, P.O. Box 2288, Mobile, AL 36628

SUBJECT: Energy Engineering Analysis Program (EEAP), Electrical Energy Demand and Usage and Heating Study, Pine Bluff Arsenal, Delivery Order No. 0004, Contract No. DACA01-94-D-0038

1. The Scope of Work/Initial Site Survey Meeting was accomplished on 13 December 1995 at Pine Bluff Arsenal. A copy of the attendance sheet is enclosed.

2. The user requested a scope change at the meeting due to conflicts with their on-going projects. The user proposed Energy Conservation Opportunity (ECO) substitutions for each current ECO that conflicted. We recommend approval of the substitutions to be processed as a no-cost modification.

3. The type of work has not changed, the area to be surveyed has not changed, and the level of effort has not changed. Enclosed you will find the Standard Form 30 (Encl 1), the modified Annexes (Encl 2), and the Contractor's Meeting Minutes (Encl 3).

4. For questions, please contact Mr. Joe Martinez (boilers), at (501) 324-6172 or Ms. Exa Hartman (motors), at (501) 324-6153.

FOR THE COMMANDER:

3 Encls

EDWARD Z. LOFTON, P.E.
Authorized Representative of the Contracting Officer

9/96

RS&H

Reynolds, Smith and Hills, Inc.

MEMORANDUM ***Architectural, Engineering, Planning and Environmental Services***

To: Distribution **Date:** 14 December 1995

From: Carlos S. Warren, PhD, PE
Project Manager

Project: Energy Engineering Analysis Program (EEAP)
Combined Limited Energy Study - Pine Bluff Arsenal
Contract No. DACA01-94-D-0038/0004
A/E No. 694-1331-004

Subject: Preliminary Site Survey
Meeting Minutes

A preliminary site survey meeting was held at Pine Bluff Arsenal (PBA) on 13 December 1995. The purpose of the meeting was to clarify the project scope of work (SOW) in light of construction projects that have been initiated at PBA.

Attendees were Nancy Rimmer, Kirk Williams and Donald Faust of PBA; Mark Emmerling, Exa Hartman and Joe Martinez of the Corps of Engineers, Little Rock; and Carlos Warren of Reynolds, Smith and Hills.

The following no-cost modifications to the SOW were agreed to by the participants:

1. Four water service pumps housed in building 42-210 will be added to the list for survey and ECO evaluation for electrical energy demand and usage.

2. A project is underway to replace the two B & W boilers in building 32-060 (Main Boiler Plant #2) with the two new 600 HP package boilers presently on hand. The SOW requirement to test and evaluate the boilers will be deleted and testing and evaluation of two boilers in building 42-960 will be added.

3. In addition to testing and evaluation of the three boilers in building 34-140 (Main Boiler Plant #4), adding a deaerator to the building will be evaluated.

4. Testing and evaluation of two boilers in building 44-120 will be added to the SOW; evaluation of installing gas fired furnaces to replace boilers in building 13-120 will be deleted.

9/96

5. Evaluation of replacing the boiler with a gas furnace in building 63-100 will be deleted from the SOW; Investigation of retrofitting the new boilers to be installed in building 32-060 with economizers will be added.

6. At the present time, six compressors are used to supply the production areas. Investigation of (1) adding the two on-hand compressors to the six in-service , or (2) replacing two of the old compressors with the new ones will be added to the SOW.

Other items:

1. Monthly progress reports will be submitted simultaneously with pay requests.

2. Project schedule will be submitted by 22 December.

3. Project effort schedule will be submitted to Little Rock by 29 December.

4. Little Rock will draft the modifications to the SOW and forward to the appropriate authorities for approval.

The balance of the meeting was devoted to walk - through surveys of the SOW sites.

Distribution:

Commander
U.S. Army, Pine Bluff Arsenal
Attn: SMCPB-EHN (Ms. Rimmer)
10020 Kabrich Circle
Pine Bluff, AR 71602-9500

Commander
U.S. Army Engineer District, Little Rock
Attn: CESWL-ED-DM (Ms. Hartman)
700 W. Capitol
P.O. Box 867
Little Rock, AR 72203-0867

Commander
U.S. Army Engineer District, Little Rock
Attn: CESWL-ED-DM (Mr. Martinez)
700 W. Capitol
P.O. Box 867
Little Rock, AR 72203-0867

Commander
U.S. Army Engineer District, Mobile
Attn: CESAM-EN-CM (Mr. Battaglia)
P.O. Box 2288
Mobile, AL 36628

ANNEX A

DETAILED SCOPE OF WORK - ELECTRICAL ENERGY DEMAND AND USAGE

1. The Architect-Engineer (A-E) shall furnish all services, material, labor, equipment, investigations, studies, superintendence and travel as required in connection with the below identified work in accordance with the general scope of work and this Detailed Scope of Work.

INSTALLATION	PROJECT TITLE
Pine Bluff Arsenal, AR	Electrical Energy Demand and Usage

2. The work and related data and services required in accordance with this Delivery Order shall be accomplished within the limitation of cost on subject project stated above and scope of work described in paragraph 3. The schedule for delivery of data to the Contracting Officer is in calendar days as follows:

DATA	DELIVERY SCHEDULE
a. Interim Submittal and Related Data or Studies	210 calendar days (after receipt of signed D.O)
b. Final Submittal	90 calendar days (after approval of Interim Submittal)

3. The items of work included in this delivery order shall be in accordance with criteria furnished at the Prestudy Conference held at Pine Bluff Arsenal, 12/13/95. The services to be provided shall include, but not be limited to, the following:

a. Items of Work. The scope of the work includes survey and evaluation of ECOs for electrical energy demand and usage for motors greater than 50 horsepower in the following buildings:

BLDG NO.	NAME OF BUILDING	SURVEY TO INCLUDE QTY	MOTOR FOR	ASSIGNED TO	SQ FT
31-630	Fill & Press	1	Compressor	Prod/Dir/OTS	12,969
32-060	Boiler & Compressor House	2	Compressor	BGU&PS Div	2,875
32-620	Colored Smoke Mix	1	Compressor	Prod Div	7,167
33-060	Boiler/Compressor	2	Compressor	BGU&PS Div	2,875
33-530	Fill & Press	1	Compressor	Prod Div	13,808
34-140	Boiler/Compressor	2	Compressor	BGU&PS Div	5,050
34-196	Evap S & D Bldg	2	Fan	DMO	4,600
42-010	Water Well No. 1	1	Water Pump	BGU&PS Div	176
42-030	Water Well No. 3	1	Water Pump	BGU&PS Div	176
42-210	Pump and Filter	4	Water Pumps	BGU&PS Div	3,816
42-960	Grenade Test Building	1	Compressor	DMMD	2,772
42-979	Afterburner Control Bldg	1	Fan	DMMD	240

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b. Government Furnished Items.

(1) As-built drawings, as available.

(2) Energy consumption data (as available) and related documents.

(3) Guide Specifications and standard motor loads and equipment details as requested.

(4) Access to facilities for the field investigation.

(5) Final reports of previously completed studies performed under the Energy Engineering Analysis Program (EEAP).

(6) Latest copies of other energy studies performed (Energy Awareness Program).

(7) ETLs 1110-3-254, Use of Electric Power for Comfort Space Heating (if applicable), and 1110-3-282, Energy Conservation.

(8) Architectural and Engineering Instructions.

(9) Energy Conservation Investment Program (ECIP) Guidance, dated 10 Jan 1994.

(10) TM 5-785, Engineering Weather Data, TM 5-800-2, General Criteria Preparation of Cost Estimates.

(11) AR 415-15, 1 Jan 84, Military Construction, Army (MCA) Program Development

(12) The latest MCP Index.

c. Special Requirements.

(1) Direct Distribution of Submittals: The AE shall make direct distribution of correspondence, minutes, report submittals, and responses to comments as indicated by the following schedule:

AGENCY	CORRESPONDENCE	EXECUTIVE SUMMARIES	REPORTS	FIELD NOTES
Commander U.S. Army, Pine Bluff Arsenal Attn: SMCPB-EHN (Ms. Rimmer) 10020 Kabrich Circle Pine Bluff, AR, 71602-9500	1	5I/5F*	5I/5F*	1**
Commander U.S. AMC Installation and Service Activity Attn: AMXEN-C (Mr. Nache) Rock Island, IL, 61299-7190	-	1	1	-
Commander U.S. Army Engineer District, Little Rock Attn: CESWL-ED-DM (Ms. Hartman) 700 West Capitol/P.O. Box 867 Little Rock, AR, 72203-0867	1	1	1	1**
Commander U.S. Army Engineer Division, Southwest Attn: CESWD-PP-MM (Mr. West) 1114 Commerce Street Dallas, TX, 75242-0216	-	1	1	-
Commander U.S. Army Engineer District, Mobile Attn: CESAM-EN-DM (Mr. Battaglia) P. O. Box 2288 Mobile, AL, 36628	1	1	1	-
Commander U.S. Army Corps of Engineers Attn: CEMP-ET (Mr. Gentil) 20 Massachusetts Avenue NW Washington, DC, 20314-1000	-	1	-	-
Commander U.S. Army Logistics Evaluation Agency Attn: LOEA-PL (Mr. Keath) New Cumberland Army Depot New Cumberland, PA, 17070-5007	-	1	-	-

* 5I/5F indicates five (5) copies at interim submittal, five (5) copies at final submittal.

** Field notes submitted in final form at interim submittal.

(2) Security Requirements. The AE shall follow the requirements as stated in Annex E while conducting site surveys.

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4. Energy Conservation Opportunities (ECOs). The following is a list of possible ECOs to be investigated in the electrical energy demand and usage study.

a. Load Shedding

(1) Isolate energy demand contributions.

(2) Reduce contracted demand limit.

b. Load Reduction

(1) Determine which loads may be reduced or dropped.

(2) Establish present energy usage and costs.

(3) Look at annual increase in energy cost associated with the usage.

(4) Replace existing motors with more energy efficient motors.

(5) Provide adjustable speed drives (ASD's) to reduce motor electrical energy usage.

c. Load Shifting

(1) Use other ways of providing power to reduce demand charge and energy usage charge.

5. Designated coordinators. The government's representative for this project is Exa Hartman. The DPW Energy coordinator, Nancy Rimmer, will serve as administrative coordinator. The DPW technical coordinator is Ralph Rimmer.

6. Analysis programs. A computer program titled Life Cycle Costing in Design (LCCID) is available from the BLAST Support Office in Urbana, Illinois for a nominal fee. This computer program can be used for performing the economic calculations for ECIP and non-ECIP ECOs. The AE is encouraged to obtain and use this computer program. The BLAST Support Office can be contacted at 144 Mechanical Engineering Building, 1206 West Green Street, Urbana, Illinois 61801. The telephone number is (217) 333-3977 or (800) 842-5278.

7. Programming year for projects meeting ECIP criteria. All projects meeting the ECIP criteria shall be programmed for FY97, others such as ECAM and Low Cost/No Cost shall be programmed as directed by the DPW.

ANNEX B

DETAILED SCOPE OF WORK - HEATING AND COMPRESSED AIR

1. The Architect-Engineer (A-E) shall furnish all services, material, labor, equipment, investigations, studies, superintendence and travel as required in connection with the below identified work in accordance with the general scope of work and this Detailed Scope of Work.

INSTALLATION	PROJECT TITLE
Pine Bluff Arsenal, AR	Heating

2. The work and related data and services required in accordance with this Delivery Order shall be accomplished within the limitation of cost on subject project stated above and scope of work described in paragraph 3. The schedule for delivery of data to the Contracting Officer and Government's representative is in calendar days as follows:

DATA	DELIVERY SCHEDULE
a. Interim Submittal and Related Data or Studies	210 calendar days (after receipt of signed D.O)
b. Final Submittal	90 calendar days (after approval of Interim Submittal)

3. The items of work included in this delivery order shall be in accordance with criteria furnished at the Prestudy Conference held at Pine Bluff Arsenal, 12/13/95. The services to be provided shall include, but not be limited to, the following:

a. Items of Work. The scope of the work includes survey and evaluation of ECOs for energy conservation opportunities for heating and compressed air systems in the following buildings:

(1) Building # 33-530, 32-620, 31-620, 31-630, 32-060, 33-060, 34-140, 42-960, 44-120.

b. Government Furnished Items.

(1) As-built drawings, as available.

(2) Energy consumption data (as available) and related documents.

(3) Guide Specifications and standard motor loads and

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equipment details as requested.

(4) Access to facilities for the field investigation.

(5) Final reports of previously completed studies performed under the Energy Engineering Analysis Program (EEAP).

(6) Latest copies of other energy studies performed (Energy Awareness Program).

(7) ETLs 1110-3-254, Use of Electric Power for Comfort Space Heating (if applicable), and 1110-3-282, Energy Conservation.

(8) Architectural and Engineering Instructions.

(9) Energy Conservation Investment Program (ECIP) Guidance, dated 10 Jan 1994.

(10) TM 5-785, Engineering Weather Data, TM 5-800-2, General Criteria Preparation of Cost Estimates.

(11) AR 415-15, 1 Jan 84, Military Construction, Army (MCA) Program Development

(12) The latest MCP Index.

(13) Sample 1391 and PDB (see enclosures).

c. Special Requirements.

(1) Direct Distribution of Submittals: The AE shall make direct distribution of correspondence, minutes, report submittals, and responses to comments as indicated by the following schedule:

AGENCY	CORRESPONDENCE	EXECUTIVE SUMMARIES	REPORTS	FIELD NOTES
Commander U.S. Army, Pine Bluff Arsenal Attn: SMCPB-EHN (Ms. Rimmer) 10020 Kabrich Circle Pine Bluff, AR, 71602-9500	1	5I/5F*	5I/5F*	1**

9/96

Commander U.S. AMC Installation and Service Activity Attn: AMXEN-C (Mr. Nache) Rock Island, IL 612999-7190	-	1	1	-
Commander U.S. Army Engineer District, Little Rock Attn: CESWL-ED-DM (Mr. Martinez) 700 West Capitol/P.O. Box 867 Little Rock, AR, 72203-0867	1	1	1	1**
Commander U.S. Army Engineer Division, Southwest Attn: CESWD-PP-MM (Mr. West) 1114 Commerce Street Dallas, TX, 75242-0216	-	1	1	-
Commander U.S. Army Engineer District, Mobile Attn: CESAM-EN-CM (Mr. Battaglia) P. O. Box 2288 Mobile, AL, 36628	1	1	1	-
Commander U.S. Army Corps of Engineers Attn: CEMP-ET (Mr. Gentil) 20 Massachusetts Avenue NW Washington, DC, 20314-1000	-	1	-	-
Commander U.S. Army Logistics Evaluation Agency Attn: LOEA-PL (Mr. Keath) New Cumberland Army Depot New Cumberland, PA, 17070-5007	-	1	-	-

* 5I/5F indicates five (5) copies at interim submittal, five (5) copies at final submittal.

** Field notes submitted in final form at interim submittal.

(2) Security Requirements. The AE shall follow the requirements as stated in Annex E while conducting site surveys.

4. Energy Conservation Opportunities (ECOs). The following is a list of possible ECOs to be investigated in the heating and compressed air study.

a. There are two ageing boilers in Bldg. 33-060 (Main Steam Plant No. 3) which feed into the main steam grid. The history of these boilers is as follows. They were installed in 1942 and were rated @ 311 Horsepower each, Babcox and Wilcox, Natural Draft. During the Vietnam era demand increased, forced draft burners were added to the boilers allowing them to operate @ more than twice their rated capacity. However, the radiant surface of the boilers was not increased, baffles were not installed, and

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consequently when the boilers are fired to their operating peak of 25,000 lb per hour (more than twice the original rated HP) the stack temperature increases to 800-1000 deg F, and the efficiency drops drastically. Current operating efficiency is approximately 60 to 70 percent when operating @ lower lb per hour steam output than the 25,000 lb per hour peak. Test these boilers for efficiency and investigate the life cycle cost of installing modern more efficient fire tube boilers possibly w/ O2 trim, turbulators, or economizer to replace the aforementioned boilers. The new boilers can be placed on a new concrete pad and sheet metal enclosure behind the building and the existing boilers remain as standby for maintenance. If less expensive, the old multistory boilers can be dismantled, removed and the same space utilized for the new boilers. Preliminary indications are that new boilers with a 20 % increase in efficiency, could possibly yield $60,000 per year or more in fuel savings and maintenance savings for the Life Cycle Cost program for this Bldg alone.

b. The two boilers in building 42-960 are 1380 lb/hr @150 psi. Test these boilers for efficiency and investigate the life cycle cost of installing more efficient fire tube boilers w/ O2 trim, turbulators, or economizers to replace the aforementioned boilers."

c. The three boilers in building 34-140 were similar to those in bldg 32-060 with the exception that these boilers were rated @ 275 HP in 1942 and increased to 20,000 lb per hour each when natural draft was changed to forced draft as described for bldg 32-060 in Paragraph 4a above. The investigation to be conducted for these boilers and the Life Cycle Cost Study for these boilers is similar in scope to that for Bldg. 32-060 in 4a above. If the study should conclude that replacing the existing boilers with new boilers is not economically feasible, then study adding a deareator for the existing boilers. A deareator must be added and included in the Life Cycle Cost Study if new boilers are considered.

d. There are two boilers in bldg. 44-120, one is a Clever Brooks CBH -200-100 rated for 4,184,000 BTU/hr @ 150 psi and the other is a 26 year old boiler rated for approx 100 HP @ 150 psi. Test these boilers for efficiency and investigate the life cycle cost of installing more efficient fire tube boilers w/O2 trim, turbulators, or economizers to replace the aforementioned boilers. Also study the installation of O2 trim and turbulators in the first (Clever Brooks) boiler as an alternative to replacing this boiler.

e. There are currently two surplus boilers stored in the vicinity of building 34-140. These boilers are to be installed and put into service under a separate contract by the Pine Bluff Arsenal. Study the economic potential savings and life cycle cost of adding an economizer to these boilers.

f. There are presently six compressors used to supply the production areas located two each in Bldgs 32-060, 33-060, & 34-

140. The Pine Bluff Arsenal has two Gardner Denver compressors Ser. No. A23794&5 in storage. Investigate the savings and life cycle cost of replacing two of the existing compressors with these new ones and/or adding these two compressors on line with the existing compressors.

5. Designated coordinators. The government's representative for this project is Joe Martinez. The DPW Energy coordinator, Nancy Rimmer, will serve as administrative coordinator. The DPW technical coordinator is Kurt Williams.

6. The efficiency of the boilers shall be determined by field testing. The AE shall provide equipment and perform the tests to establish the efficiency of the boilers. The tests are intended to determined the efficiency of the boilers as they are actually being operated. The combustion efficiency may be determined from an Orsat analysis of the flue gases. Based on the results of the tests, any indicated areas of improvement or equipment modifications shall be fully analyzed. The analysis shall evaluate boiler loading profiles versus boiler capacity and shall establish boiler efficiency and boiler operating baselines. The Government will furnish fuel, utilities and other consumables and provide personnel as needed to operate the boilers during the test. All test and measurement equipment shall be properly calibrated prior to its use.

7. Analysis programs. A computer program titled Life Cycle Costing in Design (LCCID) is available from the BLAST Support Office in Urbana, Illinois for a nominal fee. This computer program can be used for performing the economic calculations for ECIP and non-ECIP ECOs. The AE is encouraged to obtain and use this computer program. The BLAST Support Office can be contacted at 144 Mechanical Engineering Building, 1206 West Green Street, Urbana, Illinois 61801. The telephone number is (217) 333-3977 or (800) 842-5278.

8. Programming year for projects meeting ECIP criteria. All projects meeting the ECIP criteria shall be programmed for FY97, others such as ECAM and Low Cost/No Cost shall be programmed as directed by the DPW.

AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT

1. CONTRACT ID CODE	PAGE OF PAGES
	1 1

2. AMENDMENT/MODIFICATION NO.	3. EFFECTIVE DATE	4. REQUISITION/PURCHASE REQ. NO.	5. PROJECT NO. (If applicable)
02			

6. ISSUED BY CODE W41XDE	7. ADMINISTERED BY (If other than Item 6) CODE
US ARMY ENGINEER DISTRICT, MOBILE P.O. BOX 2288 MOBILE, ALABAMA 36628-0001	US ARMY ENGINEER DISTRICT, LITTLE ROCK P.O. BOX 867 LITTLE ROCK, AR 72203-0867

8. NAME AND ADDRESS OF CONTRACTOR (No., street, county, State and ZIP code)
REYNOLDS, SMITH AND HILLS, INC.
4651 SALISBURY ROAD
JACKSONVILLE, FLORIDA 32256

CODE | FACILITY CODE

(X)	
	9A. AMENDMENT OF SOLICITATION NO.
	9B. DATED (SEE ITEM 11)
X	10A. MODIFICATION OF CONTRACT/ORDER NO. Delivery Order No. 0004 Contract DACA01-94-0038
	10B. DATED (SEE ITEM 13) 95 SEP 12

11. THIS ITEM ONLY APPLIES TO AMENDMENTS OF SOLICITATIONS

☐ The above numbered solicitation is amended as set forth in Item 14. The hour and date specified for receipt of Offers ☐ is extended, ☐ is not extended.
Offers must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation or as amended, by one of the following methods:
(a) By completing Items 8 and 15, and returning _____ copies of the amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGEMENT TO BE RECEIVED AT THE PLACE DESIGNATED FOR THE RECEIPT OF OFFERS PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided each telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

12. ACCOUNTING AND APPROPRIATION DATA (If required)
152050 08-8071 P7000 S34066 RA521250001B400 $92,554.00 TOTAL DIRECT CITE ORG: NT

13. THIS ITEM APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS,
IT MODIFIES THE CONTRACT/ORDER NO. AS DESCRIBED IN ITEM 14.

(X)	
	A. THIS CHANGE ORDER IS ISSUED PURSUANT TO: (Specify authority) THE CHANGES SET FORTH IN ITEM 14 ARE MADE IN THE CONTRACT ORDER NO. IN ITEM 10A.
	B. THE ABOVE NUMBERED CONTRACT/ORDER IS MODIFIED TO REFLECT ADMINISTRATIVE CHANGES (such as changes in paying office, appropriation date, etc.)SET FORTH IN ITEM 14, PURSUANT TO AUTHORITY OF FAR 43.103(b).
X	C. THIS SUPPLEMENTAL AGREEMENT IS ENTERED INTO PURSUANT TO AUTHORITY OF: Contract Clause No. 57, CHANGES--FIXED-PRICE (ALTERNATE III)
	D. OTHER (Specify type of modification and authority)

E. IMPORTANT: Contractor ☐ is not, ☒ is required to sign this document and return origin copies to the issuing office.

14. DESCRIPTION OF AMENDMENT/MODIFICATION (Organized by UCF section headings, including solicitation/contract subject matter where feasible.)

This no cost Modification is issued to modify Energy Conservation Opportunities (ECO's) in the Scope of Work due to identification of new ECOs which offer more energy savings. Paragraph 3.a, 4.a, 4.b, and 4.c in Annex A and paragraph 3.a.1, 4.c, 4.f, and 6 in Annex B have been revised to reflect these changes.

Except as provided herein, all terms and conditions of the document referenced in Item 9A or 10A, as heretofore changed, remains unchanged and in full force and effect.

15A. NAME AND TITLE OF SIGNER (Type or print)		16A. NAME AND TITLE OF CONTRACTING OFFICER (Type or print)	
los S. Warren, PhD, PE , Project Manager		Gene L. Curtis	
15B. CONTRACTOR/OFFEROR (Signature of person authorized to sign)	15C. DATE SIGNED	16B. UNITED STATES OF AMERICA BY (Signature of Contracting Officer)	16C. DATE SIGNED

RECEIVED MAY 14 1996

DEPARTMENT OF THE ARMY
LITTLE ROCK DISTRICT, CORPS OF ENGINEERS
POST OFFICE BOX 867
LITTLE ROCK, ARKANSAS 72203-0867

REPLY TO
ATTENTION OF

CESWL-ED-DM 7 May 1996

MEMORANDUM FOR Commander, U.S. Army Engineer District, Mobile, ATTN: CESAM-EN-DM (Mr. Tony Battaglia), 109 St. Joseph Street, P.O. Box 2288, Mobile, AL 36628

SUBJECT: Energy Engineering Analysis Program (EEAP), Electrical Energy Demand and Usage and Heating Study, Pine Bluff Arsenal, Delivery Order No. 0004, Contract No. DACA01-94-D-0038

1. The AE has suggested stopping a majority of the motor ECOs and eliminating some motors since he feels they were not good candidates for energy savings due to limited operating hours. In lieu of this, he has suggested pursuing a new ECO (steam loss). He feels the new ECO will provide more energy savings. We recommend approval of the substitutions to be processed as a no-cost modification.

2. The site survey and initial investigation of ECOs on the PBA boiler data shows an enormous amount of the boiler load (>50%) is due to leaks in the steam distribution lines. We estimate about 5.5 miles of steam distribution branch lines or legs and 2 miles of header line or "high-line" exists. The DPW feels that most of the leaks are on the high-line (approximately 75%). The AE will provide an additional site survey the week of 13 May 1996 to determine how much steam is being lost in the various sections of the steam distribution system.

3. The user has jobs on-going that relate to the subject study. They are as follows:

a. Little Rock District, Corps of Engineers, Project No. 42341, Steam and Condensate System (ECIP), Pine Bluff Arsenal - Consists of replacement of exterior condensate piping in Production Area 3, Sections 1, 2, and 3 at Pine Bluff Arsenal (this is inclusive of the legs branching off the header or "high-line", approximately 5.5 miles of lines). New electric motor driven pump stations are also included. Repair/replacement of pipe supports is also included.

b. Pine Bluff Arsenal, DPW, In-house Project, Steam Line Replacement - Consisted of replacing steam lines using relatively new piping on-hand left over from the Binary Projects (this was inclusive of the legs branching off the header or "high-line", approximately 1 mile, Production Area 3, Sections 1, 2, and 3).

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The DPW has also programmed in the 5 year maintenance plan to replace more steam lines where leaking is identified on the legs as money becomes available.

c. Little Rock District, Corps of Engineers, Project No. 33574, Boiler Improvements - ECIP, Pine Bluff Arsenal - Consists of a new boiler house with two new 350 HP boilers north of building 34-120, in the White Phosphorus area. The new boilers will be connected to the existing high pressure steam main "high-line or header" as it is called.

4. From the above it appears that most of the branch steam and condensate return lines will be replaced/repaired by other projects. The user has requested that if the steam loss ECO is accepted and the steam "high-line" is replaced, provisions be made for the condensate return also. It should be noted by the AE that the existing steam high-line contains asbestos insulation and that the user wants the old line active while constructing the new line.

5. The type of work has not changed, the area to be surveyed has not changed, and the level of effort has not changed. Enclosed you will find the Standard Form 30, the modified Annexes, and AE correspondence. For questions, please contact Joe Martinez at (501) 324-6172 or Mark Emmerling at (501) 324-6905.

FOR THE COMMANDER:

Encl

Edward Z. Lofton
EDWARD Z. LOFTON, P.E.
Contracting Officer's
Representative

CF:
Dr. Carlos Warren, Reynolds, Smith and Hills, Inc., 4651 Salisbury Road, Jacksonville, Florida 32256

RS&H

Reynolds, Smith and Hills, Inc.
Architectural, Engineering, Planning and Environmental Services

Facsimile Transmittal Letter

Date: April 25, 1996

To: Mark Emmerling, Project Manager, Little Rock COE

Fax Number: 501-324-6968

From: Bill Todd for Carlos S. Warren

Sender's Phone: (904) 279 - 2281

PTAC Number: 6690 **Dept. Number:** 3011
Project Number: 694-1331-004 **Task Number:** 0400

We are transmitting 9 **pages including cover**

Comments: This fax includes a revised schedule and suggested changes for a no cost modification to the Scope of Work for the Pine Bluff Arsenal Combined Electrical Demand and Heating Study. Based on our previous site surveys, we have eliminated some buildings and ECO's that were not good candidates for energy saving projects. An additional site visit has been scheduled for the week of May 6, 1996 to determine how much steam is being lost in the various sections of the steam distribution system. Carlos will be out of the office for about two weeks. Please call me at the above number if you would like to discuss the proposed changes.

Reynolds, Smith and Hills, Inc.
4651 Salisbury Road
Jacksonville, Florida 32256
(904) 296-2000 Fax: (904) 279-2489
FL Cert. Nos. AAC001886 EB0005620 LCC000210

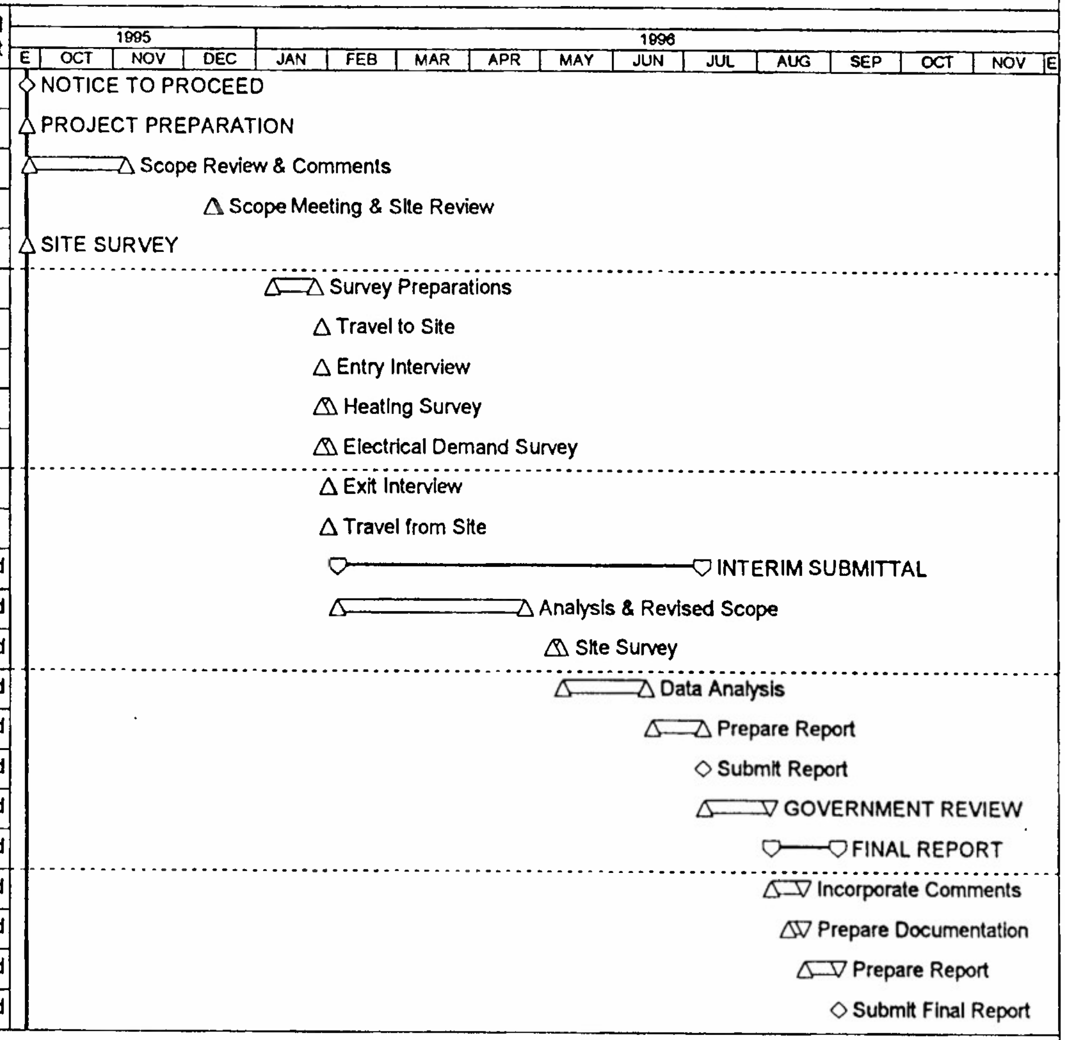
9/96

Report: Classic Gantt
Layout: Classic Gantt
Filter: All Activities

SureTrak Project Manager
PBA DEMAND & HEATING STUDY

REYNOLDS, SMITH AND HILLS, INC.
Report Date: 24APR96

Outline Code	Activity Description	Original Duration	Early Start	Early Finish	Total Float
1	NOTICE TO PROCEED	0	25SEP95 A		
2	PROJECT PREPARATION	0 *	25SEP95	25SEP95	
2.1	Scope Review & Comments	30d	26SEP95 A	06NOV95 A	
2.2	Scope Meeting & Site Review	2d	13DEC95 A	14DEC95 A	
3	SITE SURVEY	0 *	25SEP95	25SEP95	
3.1	Survey Preparations	15d	08JAN96 A	26JAN96 A	
3.2	Travel to Site	4h	29JAN96 A	29JAN96 A	
3.3	Entry Interview	1h	29JAN96 A	29JAN96 A	
3.4	Heating Survey	3d	29JAN96 A	01FEB96 A	
3.5	Electrical Demand Survey	3d	29JAN96 A	01FEB96 A	
3.6	Exit Interview	2h	01FEB96 A	01FEB96 A	
3.7	Travel from Site	4h	01FEB96 A	01FEB96 A	
4	INTERIM SUBMITTAL	109d *	05FEB96 *	08JUL96	-49d
4.1	Analysis & Revised Scope	58d	05FEB96	24APR96	-49d
4.2	Site Survey	4d	06MAY96	09MAY96	-49d
4.3	Data Analysis	25d	10MAY96	14JUN96	-49d
4.4	Prepare Report	15d	17JUN96	08JUL96	-49d
4.5	Submit Report	0		08JUL96	-49d
5	GOVERNMENT REVIEW	20d	09JUL96	05AUG96	14d
6	FINAL REPORT	20d *	06AUG96	03SEP96	14d
6.1	Incorporate Comments	10d	06AUG96	19AUG96	14d
6.2	Prepare Documentation	5d	13AUG96	19AUG96	14d
6.3	Prepare Report	10d	20AUG96	03SEP96	14d
6.4	Submit Final Report	0		03SEP96	14d



Legend		
△ Early start point	△ Progress point	
▽ Early finish point	△ Critical point	
Early bar	Summary point	
Progress bar	◇ Start milestone point	
Critical bar	◇ Finish milestone point	
Summary bar		

Data date	25SEP95
Start date	25SEP95
Finish date	03SEP96
Must finish date	23SEP96
Target finish date	

Date	Revision	Checked	Approved

A.1-50

9/96

Suggestions for a No Cost Modification to the PBA Scope of Work

ANNEX A - ELECTRICAL ENERGY DEMAND AND USAGE

Paragraph 3.a.
Eliminate Buildings 31-630, 32-620, 33-530 and 42-960. Either the compressors are no longer utilized or the entire building has been put in layaway.

Paragraph 4
Eliminate 4.a.(1) and 4.a.(2)
Eliminate 4.b.(1), 4.b.(2), 4.b.(3) and 4.b.(4)
Eliminate 4.c.(1)

ANNEX B - HEATING AND COMPRESSED AIR

Paragraph 4.a.
Eliminate Buildings 31-620, 31-630, 32-620, 33-530 and 42-960. Either the compressors are no longer utilized or the entire building has been put in layaway.

Paragraph 4.c.
Insert the following sentences (Insert A).

There is an ECIP project currently in progress to construct a new boiler house with two new 350 horsepower boilers. The new boiler house will be located north of Building 34-120 in the White Phosphorus Area. The new boilers will be connected to the existing high pressure steam main.

Paragraph 4.f.
Eliminate existing paragraph 4.f. (there is little if any energy use difference between the new compressors and the existing compressors) and insert the following new paragraph 4.f.(Insert B).

f. Determine the energy use and cost associated with leaks from the existing high pressure steam distribution system. Provide calculations, cost estimates and economic analysis for repairing or replacing the existing above ground steam distribution system between the boiler houses and the end use buildings.

Paragraph 6.
Insert the following sentence (Insert C).

The boiler and ECO analyses shall be based on the assumption that the existing high pressure steam distribution system will be repaired or replaced, and the current losses due to leaks in the steam piping system will be substantially reduced.

A.2 LIST OF ABBREVIATIONS AND ACRONYMS

List of Abbreviations and Acronyms

AP&L	Arkansas Power and Light Company
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc.
B&W	Babcock and Wilcox
BHP	Brake Horsepower
CB	Cleaver Brooks
CDG	CDG Engineers Architects Planners, Inc.
CERL	Construction Engineering Research Laboratory
CFM	Cubic Feet per Minute
CH_P	Comfort heating in the production areas
CL_P	Condensate losses in the production areas
DOD	Department of Defense
DOE	Department of Energy
DPW	Department of Public Works (at PBA)
ECIP	Energy Conservation Investment Program
ECO	Energy Conservation Opportunity
EEAP	Energy Engineering Analysis Program
EGT	Exit gas temperature
FEMP	Federal Energy Management Program
GOGO	Government Owned-Government Operated
HP	Horsepower
HR	Hour
IAT	Indoor air temperature
IB_M	Individual buildings with natural gas meters
KVA	Kilovolt-amps
KW	Kilowatts
KWH	Kilowatt-hours
LAP	Load, Assemble and Pack
LBS/HR	Pounds per hour
LCCID	Life Cycle Cost in Design
$LEAKS_P$	Steam leaks in the production areas
LF	Load Factor
LPS	Large Power Service
MBTU	Million British Thermal Units
NG_B	Total natural gas use at PBA from the utility bills
O_2	Oxygen

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O&M	Operation and Maintenance
OAT	Outside air temperature
PBA	Pine Bluff Arsenal
PE_P	Process energy used in the production areas
PF	Power Factor
PS_{31}	Process steam consumption in production area 31
PSIG	Pounds per square inch, gage
RMS	Root-mean-square
RS&H	Reynolds, Smith and Hills, Inc.
SCFM	Standard Cubic Feet per Minute
SF	Square Feet
SIOH	Supervision and Inspection Overhead
SIR	Savings to Investment Ratio
SL_P	System losses from the steam production and distribution systems
SS_P	Monthly natural gas used by the boilers in the production areas
TL_P	Thermal energy losses due to conduction in the production areas
VAR	Volt-amps reactive
WP	White Phosphorus
YR	Year

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A.3 BOILER EFFICIENCY CALCULATIONS

Determination of Average Annual boiler efficiency

To determine the average annual boiler efficiency, stack gas analysis data was taken at five different boiler loads. The five load points ranged between the boiler's published 100% and 200% capacity because that is the range where the boiler typically operates. A curve was then drawn through the data points. Samples of the boiler efficiency calculations are included in this section and the complete set of calculations are contained in Appendix B.1.

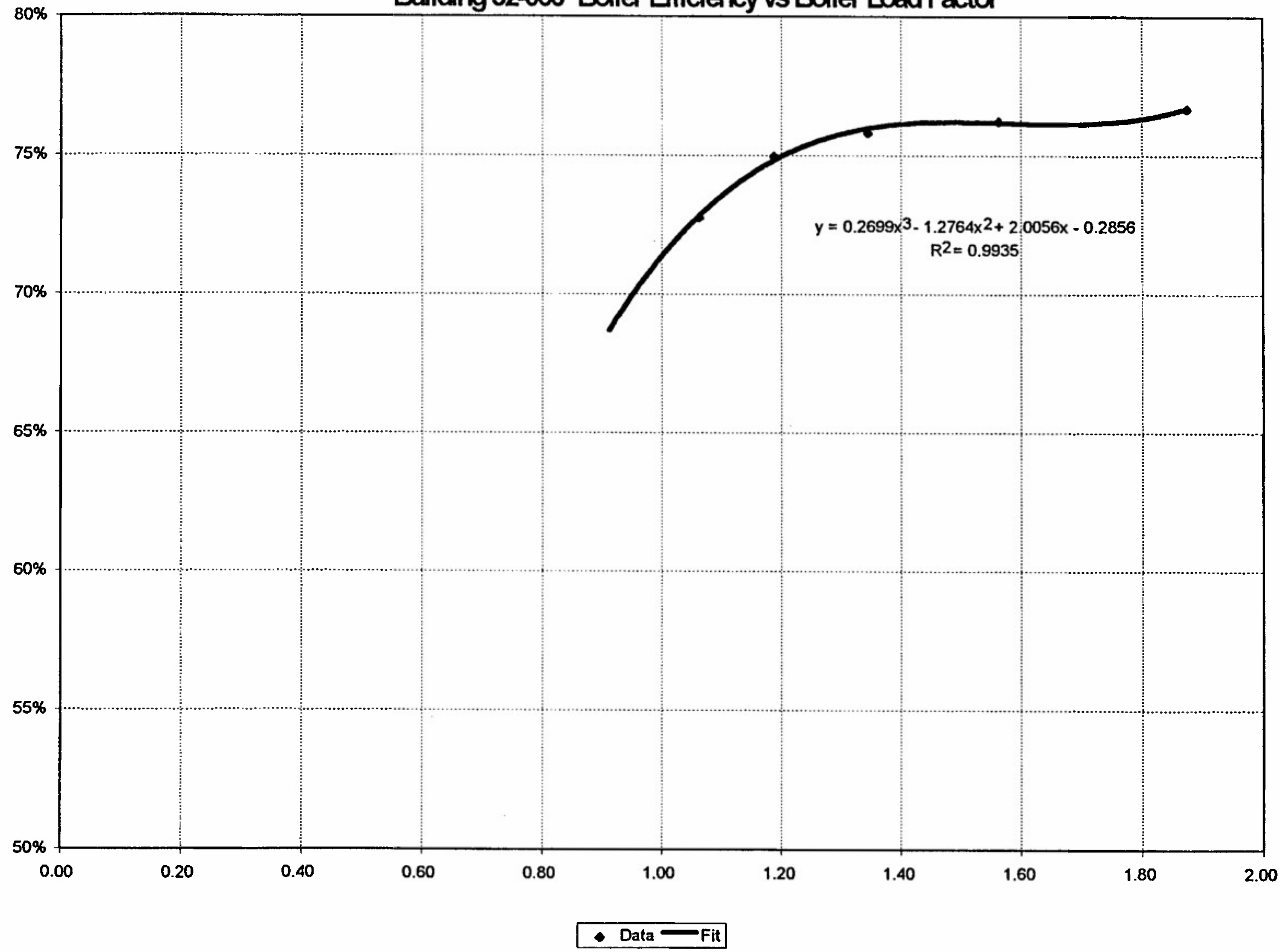
A monthly load factor was calculated from boiler operating logs. An annual average load factor was calculated from the monthly data and used to select an annual average boiler efficiency. The table below summarizes the results:

Building	Average Annual Load factor (1)	Average Annual Efficiency (2)
32-060	110%	74%
33-060	125%	75%
34-140	160%	72%

(1) Calculated from boiler operating logs. Boilers usually operate between 100% and 200% of published boiler capacity.
(2) Average annual efficiency of the boilers determined from attached graph at the average annual load factor.

PINE BLUFF ARSENAL

Building 32-060 Boiler Efficiency vs Boiler Load Factor



PINE BLUFF ARSENAL

Bldg 32-060 '95 Nat. Gas Consumption (CF/D x 1000)=(MB/D)

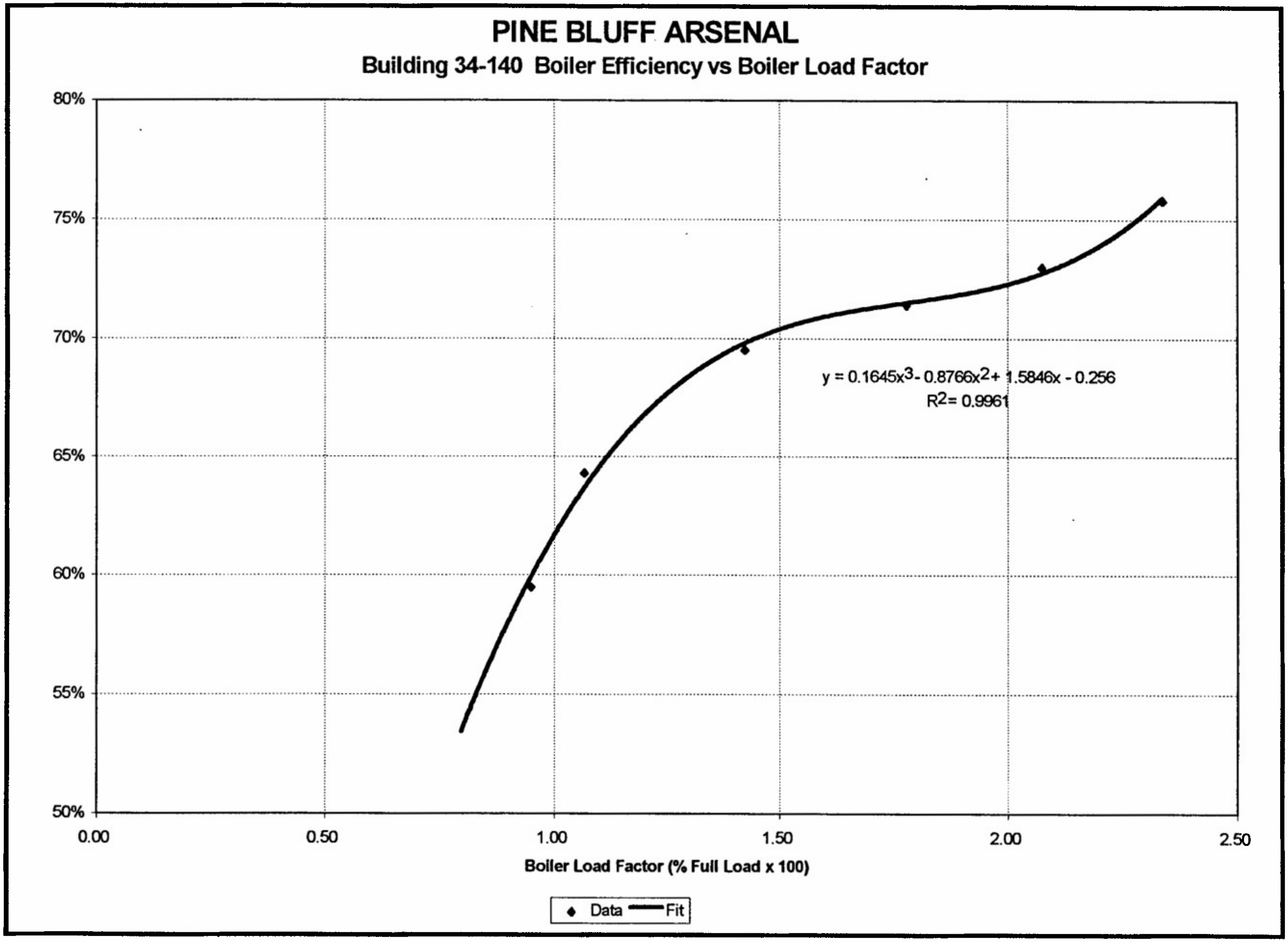
Date/Mo.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	830	653	906	353	326	390	419	359	389	0	494	468
2	676	621	844	367	480	426	439	342	337	0	420	347
3	813	1,019	737	384	311	470	446	359	349	0	403	394
4	927	979	730	426	294	410	407	377	349	389	304	435
5	767	553	658	443	263	280	475	313	120	427	331	445
6	1,030	758	549	416	404	331	420	261	0	425	415	585
7	951	766	987	443	289	336	437	280	0	422	391	524
8	907	796	809	361	359	317	442	263	0	383	460	512
9	694	787	879	377	394	379	416	297	0	429	401	646
10	659	694	660	351	363	527	343	281	0	427	254	626
11	650	795	638	393	371	403	343	796	0	428	0	737
12	611	929	413	411	363	346	316	298	0	469	133	688
13	624	876	677	307	450	342	320	309	0	444	458	608
14	747	854	474	374	421	357	291	303	0	397	374	481
15	689	730	497	380	313	349	313	217	0	267	253	480
16	630	770	650	283	334	369	267	269	0	301	476	535
17	820	720	501	276	309	373	273	288	0	319	455	557
18	834	778	397	285	421	321	340	274	0	323	386	693
19	868	607	388	324	329	320	338	334	0	327	414	904
20	0	710	316	307	311	341	370	239	0	353	443	983
21	606	644	436	313	360	530	0	296	0	324	434	961
22	624	653	373	338	337	491	0	296	0	311	477	838
23	833	584	399	326	334	546	356	297	0	333	610	898
24	784	700	320	326	339	394	343	309	0	353	771	846
25	903	561	318	336	330	469	407	314	0	356	918	895
26	1,054	577	310	314	470	362	346	366	0	373	695	940
27	1,017	627	301	320	530	450	342	283	0	358	764	870
28	1,251	759	359	258	527	351	401	420	0	307	927	852
29	1,083		339	311	484	371	397	323	0	253	624	874
30	843		370	309	462	413	390	373	0	479	474	909
31	680		351		381		373	375	0	405		769
Sum	24,405	20,500	16,586	10,412	11,659	11,764	10,770	10,111	1,544	10,382	13,959	21,300
F.L.	19,635	18,656	15,061	9,994	10,328	9,994	9,627	12,410	1,548	9,300	11,542	18,087
L.F.	124%	110%	110%	104%	113%	118%	112%	81%	100%	112%	121%	118%
Cap. =	333.1	Eff. =	0.75	Av LF =	110%							

Number of boilers in servive

Date/Mo.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	2	2	2	1	1	1	1	2	1	0	1	1
2	2	2	2	1	1	1	1	2	1	0	1	1
3	2	2	2	1	1	1	1	2	1	0	1	1
4	2	2	2	1	1	1	1	2	1	0.92	1	1
5	2	2	2	1	1	1	1	2	0.65	1	1	1
6	2	2	2	1	1	1	1	2	0	1	1	1
7	2	2	2	1	1	1	1	1	0	1	1	1
8	2	2	2	1	1	1	1	1	0	1	1	1.29
9	2	2	2	1	1	1	1	1	0	1	1	2
10	2	2	2	1	1	1	1	1	0	1	0.96	2
11	2	2	2	1	1	1	1	1	0	1	0.73	2
12	2	2	2	1	1	1	1	1	0	1	1	2
13	2	2	1.25	1	1	1	1	1	0	1	1	2
14	2	2	1	1	1	1	1	1	0	1	1	2
15	2	2	1	1	1	1	1	1	0	1	1	2
16	2	2	1.63	1	1	1	1	1.25	0	1	1	2
17	2	2	2	1	1	1	1	1	0	1	1	2
18	2	2	1.33	1	1	1	1	1	0	1	1	2
19	2	2	1	1	1	1	1	1	0	1	1	2
20	0	2	1	1	1	1	1	1	0	1	1	2
21	0.94	2	1	1	1	1	0	1	0	1	1	2
22	2	2	1	1	1	1	0	1	0	1	1	2
23	2	2	1	1	1	1	0.90	1	0	1	1	2
24	2	2	1	1	1	1	1	1	0	1	1.79	2
25	2	2	1	1	1	1	1	1	0	1	2	2
26	2	2	1	1	1	1	1	1	0	1	2	2
27	2	2	1	1	1	1	1	1	0	1	2	2
28	2	2	1	1	1	1	1	1	0	1	2	2
29	2		1	1	1	1	1	1	0	1	1.17	2
30	2		1	1	1	1	1	1	0	1	1	2
31	2		1		1		1	1		1		2
Boiler-days	58.9	56.0	45.2	30.0	31.0	30.0	28.9	37.3	4.6	27.9	34.6	54.3

PINE BLUFF ARSENAL												
Bldg 33-060 '95 nat. gas consumption (CF/D x 1000)=(MB/D)												
Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	587	427	509	343	396	324	437	0	0	354	381	399
2	526	391	487	280	394	519	407	0	0	396	348	441
3	623	0	437	304	400	530	426	0	0	432	444	452
4	626	130	483	383	403	409	405	0	0	70	436	534
5	604	413	450	331	343	434	568	0	280	0	362	500
6	686	500	380	350	474	372	461	0	367	0	421	570
7	659	477	444	377	306	347	455	0	343	0	407	608
8	581	481	481	414	331	357	450	0	358	0	485	500
9	533	488	463	387	281	474	407	0	331	0	384	495
10	557	471	401	457	382	509	0	0	293	0	310	501
11	519	478	388	386	339	447	0	0	307	0	0	497
12	546	414	360	358	373	661	0	0	302	0	46	421
13	587	445	431	318	417	586	0	0	339	0	401	355
14	556	491	416	361	297	581	0	0	319	243	394	410
15	561	534	444	360	298	611	0	0	339	273	406	381
16	546	550	406	277	236	650	0	0	341	254	462	376
17	557	543	373	468	309	591	0	0	319	264	440	348
18	647	569	414	437	311	540	0	0	340	260	397	395
19	771	511	413	341	451	650	0	0	337	301	364	454
20	725	417	476	313	417	637	0	0	363	273	446	493
21	653	476	387	313	404	543	276	0	409	270	428	451
22	611	457	374	341	417	460	371	0	388	260	148	481
23	521	423	421	346	423	511	49	0	475	287	0	490
24	499	477	324	351	454	504	0	0	436	375	0	496
25	646	446	280	297	424	580	0	0	444	315	0	533
26	664	464	377	379	457	635	0	0	450	278	0	512
27	472	433	409	388	607	540	0	0	410	280	0	625
28	31	449	383	360	524	641	0	0	456	310	0	574
29	473		420	257	555	624	0	0	0	267	292	573
30	541		446	311	388	491	0	0	398	387	497	533
31	486		412		316		0	0		353		489
Sum	17,594	12,355	12,889	10,588	12,127	15,758	4,712	0	9,144	6,502	8,699	14,887
F.L.	10,564	9,064	10,328	9,994	10,328	14,457	3,304	0	8,120	6,906	7,093	10,328
L.F.	167%	136%	125%	106%	117%	109%	143%		113%	94%	123%	144%
Cap. =	333.1467	Eff. =	0.75	Av LF =	125%							

Number of boilers in servive												
1	1	1	1	1	1	1	1	0	0	1	1	1
2	1	1	1	1	1	1	1	0	0	1	1	1
3	1	0.25	1	1	1	1	1	0	0	1	1	1
4	1	0.96	1	1	1	1	1	0	0	0.35	1	1
5	1	1	1	1	1	1	1	0	0.38	0	1	1
6	1	1	1	1	1	1	1	0	1	0	1	1
7	1	1	1	1	1	1	1	0	1	0	1	1
8	1	1	1	1	1	1	1	0	1	0	1	1
9	1	1	1	1	1	1	0.25	0	1	0	1	1
10	1	1	1	1	1	1	0	0	1	0	0.71	1
11	1	1	1	1	1	1.38	0	0	1	0	0	1
12	1	1	1	1	1	2	0	0	1	0	0.29	1
13	1	1	1	1	1	2	0	0	1	0	1	1
14	1	1	1	1	1	2	0	0	1	0.38	1	1
15	1	1	1	1	1	2	0	0	1	1	1	1
16	1.10	1	1	1	1	2	0	0	1	1	1	1
17	1	1	1	1	1	2	0	0	1	1	1	1
18	1	1	1	1	1	2	0	0	1	1	1	1
19	1.17	1	1	1	1	2	0	0	1	1	1	1
20	2	1	1	1	1	2	0	0	1	1	1	1
21	1.40	1	1	1	1	1.48	0.54	0	1	1	1	1
22	1	1	1	1	1	1	1	0	1	1	0.67	1
23	1	1	1	1	1	1	0.13	0	1	1	0	1
24	1	1	1	1	1	1	0	0	1	1	0	1
25	1	1	1	1	1	1.29	0	0	1	1	0	1
26	1	1	1	1	1	2	0	0	1	1	0	1
27	1	1	1	1	1	2	0	0	1	1	0	1
28	0.38	1	1	1	1	2	0	0	1	1	0	1
29	0.67		1	1	1	1.25	0	0	0.25	1	0.63	1
30	1		1	1	1	1	0	0	0.75	1	1	1
31	1		1		1		0	0		1		1
Boiler-days	31.7	27.2	31.0	30.0	31.0	43.4	9.9	0.0	24.4	20.7	21.3	31.0


PINE BLUFF ARSENAL
Building 34-140 Boiler Efficiency vs Boiler Load Factor
80%
75%
70%
65%
60%
55%
50%
0.00
0.50
1.00
1.50
2.00
2.50
Boiler Load Factor (% Full Load x 100)
y = 0.1645x3- 0.8766x2+ 1.5846x - 0.256
R2= 0.9961
Data
Fit

PINE BLUFF ARSENAL

Bldg 34-140 '95 nat. gas consumption (CF/D x 1000)=(MB/D)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	619	957	971	595	523	375	0	639	377	520	461	904
2	692	890	971	601	552	0	0	490	391	503	487	764
3	609	1041	889	623	550	0	0	494	387	548	491	823
4	667	1026	993	724	503	443	0	519	451	554	683	873
5	939	918	891	573	550	464	0	493	258	511	490	809
6	663	946	584	547	318	335	0	476	437	549	541	993
7	667	1007	897	560	524	354	0	476	483	551	526	959
8	643	1010	892	510	443	351	0	486	435	436	570	931
9	884	1080	896	511	437	0	0	507	518	480	587	968
10	663	899	887	501	401	0	441	523	502	454	607	971
11	576	712	771	576	389	0	440	523	514	521	834	990
12	574	1077	804	601	450	0	423	547	353	481	856	971
13	610	951	643	613	134	0	430	484	494	510	669	976
14	620	982	674	597	266	0	461	482	483	415	714	851
15	573	897	660	578	435	0	475	569	487	365	667	862
16	600	924	602	521	418	0	477	469	497	393	580	874
17	599	886	549	530	190	0	546	432	456	380	553	947
18	624	929	618	421	346	0	441	405	510	371	486	979
19	823	926	639	546	350	0	432	390	507	381	781	1043
20	1182	902	672	573	287	0	493	441	535	391	549	1060
21	1049	905	663	534	380	0	581	413	574	410	569	874
22	1052	878	629	591	337	0	440	451	561	385	644	844
23	976	855	622	574	324	0	492	464	522	387	664	892
24	956	708	659	564	355	0	530	478	541	394	636	894
25	727	843	630	544	309	0	630	491	581	441	589	898
26	454	828	589	527	0	0	534	481	561	407	556	897
27	656	776	636	560	0	0	563	306	531	372	810	944
28	1054	904	652	500	0	0	538	357	513	437	947	878
29	861		658	451	191	0	654	374	651	391	944	874
30	1080		636	506	427	0	526	498	470	453	935	894
31	1019		637		418		509	414		460		882
Sum	23,711	25,657	22,514	16,652	10,807	2,322	11,056	14,572	14,580	13,851	19,426	28,319
F.L.	12,313	16,004	17,195	9,621	7,645	1,703	6,287	8,716	8,574	8,859	12,074	17,719
L.F.	193%	160%	131%	173%	141%	136%	176%	167%	170%	156%	161%	160%
Cap. =	285.8	Eff =	0.70	Av LF =	160%							

Number of boilers in servive

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1	2	2	2	1	1	0	1	1	1	1	2
2	1	2	2	2	1	0.25	0	1	1	1	1	2
3	1	2	2	2	1	0	0	1	1	1	1	2
4	1	2	2	1.67	1	0.46	0	1	1	1	1.04	2
5	1.63	2	2	1	1	1	0	1	1	1	1	2
6	1.38	2	2	1	0.63	1	0	1	1	1	1	2
7	1	2	2	1	1	1	0	1	1	1	1	2
8	1.88	2	2	1	1	1	0	1	1	1	1	2
9	2	2	2	1	1	0.25	0	1	1	1	1	2
10	1.42	2	2	1	1	0	1	1	1	1	1.17	2
11	1	2	2	1	1	0	1	1	1	1	2	2
12	1	2	2	1	1	0	1	1	1	1	1.5	2
13	1	2	2	1	1	0	1	1	1	1	1.63	2
14	1	2	2	1	0.5	0	1	1	1	1	1.38	2
15	1	2	1.75	1	1	0	1	0.67	1	1	1	2
16	1	2	1	1	1	0	1	1	1	1	1	2
17	1	2	1.42	1	1	0	1	1	1	1	1	2
18	1	2	2	1	1	0	1	1	1	1	1	2
19	1.25	2	2	1	1	0	1	1	1	1	1	2
20	2	2	2	1	1	0	1	1	1	1	1	2
21	2	2	2	1	1	0	1	1	1	1	1.54	2
22	2	2	2	1	1	0	1	1	1	1	2	2
23	2	2	2	1	1	0	1	1	1	1	2	2
24	2	2	2	1	1	0	1	1	1	1	2	2
25	1.38	2	2	1	1	0	1	1	1	1	2	2
26	1	2	2	1	0.25	0	1	1	1	1	2	2
27	1	2	2	1	0	0	1	1	1	1	2	2
28	1.67	2	2	1	0	0	1	0.83	1	1	2	2
29	1.5		2	1	0.38	0	1	1	1	1	2	2
30	2		2	1	1	0	1	1	1	1	2	2
31	2		2		1		1	1		1		2
Boiler-days	43.1	56.0	60.2	33.7	26.8	6.0	22.0	30.5	30.0	31.0	42.3	62.0

COMBUSTION CALCULATIONS

INPUT

CLIENT: RSH DATE: Apr 4,1996

PLANT: PINE BLUFF ARSENAL TIME: 03:39 PM

Bldg.32-060,125 psig ,11.7% Stack O2,400 EGT,11875pph

FUEL ULTIMATE ANALYSIS

CONSTITUENT	WT.PCT.	RECEIVED	DRY & ASH FREE	ADJUSTED/ AS FIRED
CARBON	75.00	0.75	0.75	75.00
HYDROGEN	25.00	0.25	0.25	25.00
OXYGEN	0.00	0.00	0.00	0.00
NITROGEN	0.00	0.00	0.00	0.00
SULFUR	0.00	0.00	0.00	0.00
CHLORINE	0.00	0.00	0.00	0.00
WATER	0.00	0.00	0.00	0.00
INERTS	0.00	0.00	0.00	0.00
TOTAL	100.00	1.00	1.00	100.00

FUEL RATE (TONS/DAY)	8.09
TOTAL AIR ASSIGNED (%)	246
FUEL HIGHER HEATING VALUE (BTU/LB)	23896
HEAT LOSS DUE TO UNBURNED CARBON (%)	0.00
CARBON IN RESIDUE (%)	0.00
EXIT GAS TEMPERATURE (Deg. F)	400
AMBIENT DRY BULB TEMP (Deg.F)	80
HUMIDITY RATIO (LBS H2O/LB DRY AIR)	0.0132
BAROMETRIC PRESSURE (IN.Hg.)	29.92
RADIATION LOSS (%)	0.00
UNACCOUNTABLE LOSS (%)	0.00
ENTHALPY ADDED IN BOILER (BTU/LB)	1017

FANS

	STAT.PRES (IN.H2O)	EFFICIENCY (%)	AIR SUPPLIED (% TOT.)	TEST BLOCK FLOW (%)	TEST BLOCK STATIC (%)
PRIMARY	5.0	82.0	100	10	20
SECONDARY	0.0	82.0	0	20	44
INDUCED DRAFT	0.0	85.0		25	56

COMBUSTION CALCULATIONS

OUTPUT

CLIENT: RSH DATE: Apr 4,1996

PLANT: PINE BLUFF ARSENAL TIME: 03:39 PM
Bldg.32-060,125 psig ,11.7% Stack O2,400 EGT,11875pph

HEAT LOSSES	MBTU /HR	PERCENT
IN DRY FLUE GAS	2.19	13.59
FROM H2O IN AIR	0.06	0.34
FROM H20 IN FUEL--SENSIBLE	0.22	1.37
FROM H20 IN FUEL--LATENT	1.57	9.72
TOTAL IN WET FLUE GAS	4.03	25.02
DUE TO UNBURNED CARBON	0.00	0.00
DUE TO HOT ASH	0.00	0.00
DUE TO RADIATION & UNACCOUNTABLE	0.00	0.00
TOTAL	4.03	25.02

BOILER EFFICIENCY (%)	74.98
STEAM GENERATED (LBS/HR)	11875
UNBURNED CARBON (LBS/HR)	0
LBS OF WET FLUE GAS PER LB FUEL	43.92
SPEC.VOL.OF WET FLUE GAS (CU.FT./LB)	22.23
AIR TO FUEL RATIO (LB AIR/LB FUEL)	42.36
COMB. AIR SPECIFIC VOL. (CU.FT/LB)	13.712
COMBUSTION AIR FLOW (LBS/HR)	28933

FLUE GAS ANALYSIS

	% BY VOLUME		% BY WEIGHT	
	WET	DRY	WET	DRY
CO2	4.01	4.46	6.26	6.68
SO2	0.0000	0.0000	0.0000	0.0000
O2	11.70	13.00	13.26	14.16
HCL	0.0000	0.0000	0.0000	0.0000
N2	74.32	82.55	74.12	79.16
H2O	9.97		6.36	

COMBUSTION CALCULATIONS
OUTPUT

CLIENT: RSH DATE: Apr 04,1996

PLANT: PINE BLUFF ARSENAL TIME: 3:39 PM
Bldg.32-060,125 psig ,11.7% Stack O2,400 EGT,11875pph

FLUE GAS FLOWS

	WET	DRY
MASS (LBS/HR)	29607	27724
VOLUME (ACFM)	10970	9877
(SCFM)(70DEG.F.)	6761	6087
@ 12% CO2	20216	16387
"F" FACTOR		
(DSCF/MMBTU @12% CO2)		61043

FAN DATA

	NET			TEST BLOCK		
	LBS/HR	ACFM	BHP	LBS/HR	ACFM	BHP
PRIMARY	28933	6612	6.34	31826	7273	8.37
SECONDARY	0	0	0	0	0	0
INDUCED	29607	10970	0	37009	13713	0

COMBUSTION CALCULATIONS

INPUT

CLIENT: RSH DATE: Jun 28,1996

PLANT: PINE BLUFF ARSENAL TIME: 11:34 AM

Bldg.32-060,125 psig ,10%excess air, 250 EGT,25000pph

WITH ECONOMIZER

FUEL ULTIMATE ANALYSIS

CONSTITUENT	WT.PCT.	RECEIVED	DRY & ASH FREE	ADJUSTED/ AS FIRED
CARBON	75.00	0.75	0.75	75.00
HYDROGEN	25.00	0.25	0.25	25.00
OXYGEN	0.00	0.00	0.00	0.00
NITROGEN	0.00	0.00	0.00	0.00
SULFUR	0.00	0.00	0.00	0.00
CHLORINE	0.00	0.00	0.00	0.00
WATER	0.00	0.00	0.00	0.00
INERTS	0.00	0.00	0.00	0.00
TOTAL	100.00	1.00	1.00	100.00

FUEL RATE (TONS/DAY)	14.77
TOTAL AIR ASSIGNED (%)	110
FUEL HIGHER HEATING VALUE (BTU/LB)	23896
HEAT LOSS DUE TO UNBURNED CARBON (%)	0.00
CARBON IN RESIDUE (%)	0.00
EXIT GAS TEMPERATURE (Deg. F)	250
AMBIENT DRY BULB TEMP (Deg.F)	80
HUMIDITY RATIO (LBS H2O/LB DRY AIR)	0.0132
BAROMETRIC PRESSURE (IN.Hg.)	29.92
RADIATION LOSS (%)	0.00
UNACCOUNTABLE LOSS (%)	0.00
ENTHALPY ADDED IN BOILER (BTU/LB)	1017

FANS

	STAT.PRES (IN.H2O)	EFFICIENCY (%)	AIR SUPPLIED (% TOT.)	TEST BLOCK FLOW (%)	TEST BLOCK STATIC (%)
PRIMARY	5.0	82.0	100	10	20
SECONDARY	0.0	82.0	0	20	44
INDUCED DRAFT	0.0	85.0		25	56

COMBUSTION CALCULATIONS

OUTPUT

CLIENT: RSH DATE: Jun 28,1996

PLANT: PINE BLUFF ARSENAL TIME: 11:34 AM
Bldg.32-060,125 psig ,10%excess air, 250 EGT,25000pph

HEAT LOSSES	MBTU /HR	PERCENT
IN DRY FLUE GAS	0.89	3.04
FROM H2O IN AIR	0.02	0.08
FROM H20 IN FUEL--SENSIBLE	0.21	0.71
FROM H20 IN FUEL--LATENT	2.86	9.72
TOTAL IN WET FLUE GAS	3.99	13.55
DUE TO UNBURNED CARBON	0.00	0.00
DUE TO HOT ASH	0.00	0.00
DUE TO RADIATION & UNACCOUNTABLE	0.00	0.00
TOTAL	3.99	13.55

BOILER EFFICIENCY (%)	86.45
STEAM GENERATED (LBS/HR)	25000
UNBURNED CARBON (LBS/HR)	0
LBS OF WET FLUE GAS PER LB FUEL	20.18
SPEC.VOL.OF WET FLUE GAS (CU.FT./LB)	18.73
AIR TO FUEL RATIO (LB AIR/LB FUEL)	18.93
COMB. AIR SPECIFIC VOL. (CU.FT/LB)	13.712
COMBUSTION AIR FLOW (LBS/HR)	23602

FLUE GAS ANALYSIS

	% BY VOLUME		% BY WEIGHT	
	WET	DRY	WET	DRY
CO2	8.56	10.56	13.62	15.53
SO2	0.0000	0.0000	0.0000	0.0000
O2	1.71	2.11	1.98	2.26
HCL	0.0000	0.0000	0.0000	0.0000
N2	70.83	87.33	72.09	82.21
H2O	18.90		12.31	

COMBUSTION CALCULATIONS

OUTPUT

CLIENT: RSH   DATE: Jun 28,1996

PLANT: PINE BLUFF ARSENAL   TIME: 11:34 AM

Bldg.32-060,125 psig ,10%excess air, 250 EGT,25000pph

FLUE GAS FLOWS

	WET	DRY
MASS (LBS/HR)	24833	21776
VOLUME (ACFM)	7753	6287
(SCFM)(70DEG.F.)	5787	4693
@ 12% CO2	8113	5335
"F" FACTOR		
(DSCF/MMBTU @12% CO2)		10885

FAN DATA

	NET			TEST BLOCK		
	LBS/HR	ACFM	BHP	LBS/HR	ACFM	BHP
PRIMARY	23602	5394	5.17	25962	5933	6.83
SECONDARY	0	0	0	0	0	0
INDUCED	24833	7753	0	31041	9691	0

COMBUSTION CALCULATIONS
INPUT

CLIENT: RSH DATE: Mar 29,1996

PLANT: PINE BLUFF ARSENAL TIME: 03:20 PM
Bldg.34-140,140 psig ,7.3% Stack O2, 15k#/h,638F

FUEL ULTIMATE ANALYSIS

CONSTITUENT	WT.PCT.	RECEIVED	DRY & ASH FREE	ADJUSTED/ AS FIRED
CARBON	75.00	0.75	0.75	75.00
HYDROGEN	25.00	0.25	0.25	25.00
OXYGEN	0.00	0.00	0.00	0.00
NITROGEN	0.00	0.00	0.00	0.00
SULFUR	0.00	0.00	0.00	0.00
CHLORINE	0.00	0.00	0.00	0.00
WATER	0.00	0.00	0.00	0.00
INERTS	0.00	0.00	0.00	0.00
TOTAL	100.00	1.00	1.00	100.00

FUEL RATE (TONS/DAY)	10.74
TOTAL AIR ASSIGNED (%)	161
FUEL HIGHER HEATING VALUE (BTU/LB)	23896
HEAT LOSS DUE TO UNBURNED CARBON (%)	0.00
CARBON IN RESIDUE (%)	0.00
EXIT GAS TEMPERATURE (Deg. F)	638
AMBIENT DRY BULB TEMP (Deg.F)	80
HUMIDITY RATIO (LBS H2O/LB DRY AIR)	0.0132
BAROMETRIC PRESSURE (IN.Hg.)	29.92
RADIATION LOSS (%)	0.00
UNACCOUNTABLE LOSS (%)	0.00
ENTHALPY ADDED IN BOILER (BTU/LB)	1019

FANS

	STAT.PRES (IN.H2O)	EFFICIENCY (%)	SUPPLIED (% TOT.)	FLOW (%)	STATIC (%)
PRIMARY	5.0	82.0	100	10	20
SECONDARY	0.0	82.0	0	20	44
INDUCED DRAFT	0.0	85.0		25	56

COMBUSTION CALCULATIONS

OUTPUT

CLIENT: RSH　　　　DATE: Mar 29,1996

PLANT: PINE BLUFF ARSENAL　　　　TIME: 03:20 PM
Bldg.34-140,140 psig ,7.3% Stack O2, 15k#/h,638F

HEAT LOSSES	MBTU /HR	PERCENT
IN DRY FLUE GAS	3.41	15.92
FROM H2O IN AIR	0.09	0.41
FROM H20 IN FUEL--SENSIBLE	0.54	2.51
FROM H20 IN FUEL--LATENT	2.08	9.72
TOTAL IN WET FLUE GAS	6.11	28.57
DUE TO UNBURNED CARBON	0.00	0.00
DUE TO HOT ASH	0.00	0.00
DUE TO RADIATION & UNACCOUNTABLE	0.00	0.00
TOTAL	6.11	28.57

BOILER EFFICIENCY (%)	71.43
STEAM GENERATED (LBS/HR)	15000
UNBURNED CARBON (LBS/HR)	0
LBS OF WET FLUE GAS PER LB FUEL	29.04
SPEC.VOL.OF WET FLUE GAS (CU.FT./LB)	28.64
AIR TO FUEL RATIO (LB AIR/LB FUEL)	27.67
COMB. AIR SPECIFIC VOL. (CU.FT/LB)	13.712
COMBUSTION AIR FLOW (LBS/HR)	25099

FLUE GAS ANALYSIS

	% BY VOLUME		% BY WEIGHT	
	WET	DRY	WET	DRY
CO2	6.02	6.99	9.46	10.39
SO2	0.0000	0.0000	0.0000	0.0000
O2	7.30	8.48	8.35	9.17
HCL	0.0000	0.0000	0.0000	0.0000
N2	72.78	84.53	73.24	80.44
H2O	13.90		8.95	

COMBUSTION CALCULATIONS
OUTPUT

CLIENT: RSH DATE: Mar 29,1996

PLANT: PINE BLUFF ARSENAL TIME: 3:20 PM
Bldg.34-140,140 psig ,7.3% Stack O2, 15k#/h,638F

FLUE GAS FLOWS

	WET	DRY
MASS (LBS/HR)	25994	23668
VOLUME (ACFM)	12407	10683
(SCFM)(70DEG.F.)	5989	5156
@ 12% CO2	11946	8855
"F" FACTOR (DSCF/MMBTU @12% CO2)		24839

FAN DATA

	NET			TEST BLOCK		
	LBS/HR	ACFM	BHP	LBS/HR	ACFM	BHP
PRIMARY	25099	5736	5.50	27609	6310	7.26
SECONDARY	0	0	0	0	0	0
INDUCED	25994	12407	0	32493	15509	0

W/FUEL - AIR MIXTURE CONTROLS

COMBUSTION CALCULATIONS

INPUT

CLIENT: RSH DATE: Mar 21,1996

PLANT: PINE BLUFF ARSENAL TIME: 07:45 PM
Bldg.34-140,125 psig ,10% Excess Air, 249HP

FUEL ULTIMATE ANALYSIS

CONSTITUENT	WT.PCT.	RECEIVED	DRY & ASH FREE	ADJUSTED/ AS FIRED
CARBON	75.00	0.75	0.75	75.00
HYDROGEN	25.00	0.25	0.25	25.00
OXYGEN	0.00	0.00	0.00	0.00
NITROGEN	0.00	0.00	0.00	0.00
SULFUR	0.00	0.00	0.00	0.00
CHLORINE	0.00	0.00	0.00	0.00
WATER	0.00	0.00	0.00	0.00
INERTS	0.00	0.00	0.00	0.00
TOTAL	100.00	1.00	1.00	100.00

FUEL RATE (TONS/DAY)	5.17
TOTAL AIR ASSIGNED (%)	110
FUEL HIGHER HEATING VALUE (BTU/LB)	23896
HEAT LOSS DUE TO UNBURNED CARBON (%)	0.00
CARBON IN RESIDUE (%)	0.00
EXIT GAS TEMPERATURE (Deg. F)	478
AMBIENT DRY BULB TEMP (Deg.F)	80
HUMIDITY RATIO (LBS H2O/LB DRY AIR)	0.0132
BAROMETRIC PRESSURE (IN.Hg.)	29.92
RADIATION LOSS (%)	0.00
UNACCOUNTABLE LOSS (%)	0.00
ENTHALPY ADDED IN BOILER (BTU/LB)	1017

FANS

	STAT.PRES (IN.H2O)	EFFICIENCY (%)	SUPPLIED (% TOT.)	FLOW (%)	STATIC (%)
PRIMARY	5.0	82.0	100	10	20
SECONDARY	0.0	82.0	0	20	44
INDUCED DRAFT	0.0	85.0		25	56

COMBUSTION CALCULATIONS

OUTPUT

CLIENT: RSH — DATE: Mar 21,1996

PLANT: PINE BLUFF ARSENAL — TIME: 07:45 PM
Bldg.34-140,125 psig ,10% Excess Air, 249HP

HEAT LOSSES	MBTU /HR	PERCENT
IN DRY FLUE GAS	0.76	7.41
FROM H2O IN AIR	0.02	0.19
FROM H20 IN FUEL--SENSIBLE	0.18	1.73
FROM H20 IN FUEL--LATENT	1.00	9.72
TOTAL IN WET FLUE GAS	1.96	19.06
DUE TO UNBURNED CARBON	0.00	0.00
DUE TO HOT ASH	0.00	0.00
DUE TO RADIATION & UNACCOUNTABLE	0.00	0.00
TOTAL	1.96	19.06

BOILER EFFICIENCY (%)	80.94
STEAM GENERATED (LBS/HR)	8196
UNBURNED CARBON (LBS/HR)	0
LBS OF WET FLUE GAS PER LB FUEL	20.17
SPEC.VOL.OF WET FLUE GAS (CU.FT./LB)	24.75
AIR TO FUEL RATIO (LB AIR/LB FUEL)	18.92
COMB. AIR SPECIFIC VOL. (CU.FT/LB)	13.712
COMBUSTION AIR FLOW (LBS/HR)	8262

FLUE GAS ANALYSIS

	% BY VOLUME		% BY WEIGHT	
	WET	DRY	WET	DRY
CO2	8.56	10.56	13.62	15.54
SO2	0.0000	0.0000	0.0000	0.0000
O2	1.71	2.10	1.97	2.25
HCL	0.0000	0.0000	0.0000	0.0000
N2	70.82	87.34	72.09	82.21
H2O	18.91		12.31	

COMBUSTION CALCULATIONS
OUTPUT

CLIENT: RSH — DATE: Mar 21,1996

PLANT: PINE BLUFF ARSENAL — TIME: 7:45 PM
Bldg.34-140,125 psig ,10% Excess Air, 249HP

FLUE GAS FLOWS

	WET	DRY
MASS (LBS/HR)	8693	7622
VOLUME (ACFM)	3585	2908
(SCFM)(70DEG.F.)	2026	1643
@ 12% CO2	2839	1867
"F" FACTOR		
(DSCF/MMBTU @12% CO2)		10879

FAN DATA

	NET			TEST BLOCK		
	LBS/HR	ACFM	BHP	LBS/HR	ACFM	BHP
PRIMARY	8262	1888	1.81	9088	2077	2.39
SECONDARY	0	0	0	0	0	0
INDUCED	8693	3585	0	10866	4482	0

COMBUSTION CALCULATIONS
INPUT

CLIENT: RSH   DATE: Mar 14,1996

PLANT: PINE BLUFF ARSENAL   TIME: 03:30 PM
Bldg.42960,50psig ,1.6% Stack O2

FUEL ULTIMATE ANALYSIS

CONSTITUENT	WT.PCT.	RECEIVED	DRY & ASH FREE	ADJUSTED/ AS FIRED
CARBON	75.00	0.75	0.75	75.00
HYDROGEN	25.00	0.25	0.25	25.00
OXYGEN	0.00	0.00	0.00	0.00
NITROGEN	0.00	0.00	0.00	0.00
SULFUR	0.00	0.00	0.00	0.00
CHLORINE	0.00	0.00	0.00	0.00
WATER	0.00	0.00	0.00	0.00
INERTS	0.00	0.00	0.00	0.00
TOTAL	100.00	1.00	1.00	100.00

FUEL RATE (TONS/DAY)	0.90
TOTAL AIR ASSIGNED (%)	109
FUEL HIGHER HEATING VALUE (BTU/LB)	23896
HEAT LOSS DUE TO UNBURNED CARBON (%)	0.00
CARBON IN RESIDUE (%)	0.00
EXIT GAS TEMPERATURE (Deg. F)	548
AMBIENT DRY BULB TEMP (Deg.F)	80
HUMIDITY RATIO (LBS H2O/LB DRY AIR)	0.0132
BAROMETRIC PRESSURE (IN.Hg.)	29.92
RADIATION LOSS (%)	0.50
UNACCOUNTABLE LOSS (%)	0.00
ENTHALPY ADDED IN BOILER (BTU/LB)	1024

FANS

	STAT.PRES (IN.H2O)	EFFICIENCY (%)	SUPPLIED (% TOT.)	FLOW (%)	STATIC (%)
PRIMARY	5.0	82.0	100	10	20
SECONDARY	0.0	82.0	0	20	44
INDUCED DRAFT	0.0	85.0		25	56

COMBUSTION CALCULATIONS

OUTPUT

CLIENT: RSH　　　　　　　　　　　　　　　　DATE: Mar 14,1996

PLANT: PINE BLUFF ARSENAL　　　　　　　　　TIME: 03:30 PM
Bldg.42960,50psig ,1.6% Stack O2

HEAT LOSSES	MBTU /HR	PERCENT
IN DRY FLUE GAS	0.16	8.78
FROM H2O IN AIR	0.00	0.23
FROM H20 IN FUEL--SENSIBLE	0.04	2.06
FROM H20 IN FUEL--LATENT	0.17	9.72
TOTAL IN WET FLUE GAS	0.37	20.79
DUE TO UNBURNED CARBON	0.00	0.00
DUE TO HOT ASH	0.00	0.00
DUE TO RADIATION & UNACCOUNTABLE	0.01	0.50
TOTAL	0.38	21.29

BOILER EFFICIENCY (%)	78.71
STEAM GENERATED (LBS/HR)	1380
UNBURNED CARBON (LBS/HR)	0
LBS OF WET FLUE GAS PER LB FUEL	20.05
SPEC.VOL.OF WET FLUE GAS (CU.FT./LB)	26.60
AIR TO FUEL RATIO (LB AIR/LB FUEL)	18.81
COMB. AIR SPECIFIC VOL. (CU.FT/LB)	13.712
COMBUSTION AIR FLOW (LBS/HR)	1432

FLUE GAS AN

	% BY VOLUME		% BY WEIGHT	
	WET	DRY	WET	DRY
CO_2	8.61	10.63	13.70	15.64
SO_2	0.0000	0.0000	0.0000	0.0000
O_2	1.60	1.98	1.85	2.11
HCL	0.0000	0.0000	0.0000	0.0000
N_2	70.79	87.39	72.07	82.25
H_2O	19.00		12.38	

COMBUSTION CALCULATIONS
OUTPUT

CLIENT: RSH

DATE: Mar 14,1996

PLANT: PINE BLUFF ARSENAL
Bldg.42960,50psig ,1.6% Stack O2

TIME: 3:30 PM

FLUE GAS FLOWS

	WET	DRY
MASS (LBS/HR)	1507	1320
VOLUME (ACFM)	668	541
(SCFM)(70DEG.F.)	351	284
@ 12% CO2	489	321
"F" FACTOR (DSCF/MMBTU @12% CO2)		10732

FAN DATA

	NET			TEST BLOCK		
	LBS/HR	ACFM	BHP	LBS/HR	ACFM	BHP
PRIMARY	1432	327	0	1575	360	0
SECONDARY	0	0	0	0	0	0
INDUCED	1507	668	0	1883	835	0

COMBUSTION CALCULATIONS

INPUT

CLIENT: RSH — DATE: Apr 4,1996

PLANT: PINE BLUFF ARSENAL — TIME: 05:46 PM
Bldg.44-120,30 psig ,1.6% Stack O2,333 EGT

FUEL ULTIMATE ANALYSIS

CONSTITUENT	WT.PCT.	RECEIVED	DRY & ASH FREE	ADJUSTED/ AS FIRED
CARBON	75.00	0.75	0.75	75.00
HYDROGEN	25.00	0.25	0.25	25.00
OXYGEN	0.00	0.00	0.00	0.00
NITROGEN	0.00	0.00	0.00	0.00
SULFUR	0.00	0.00	0.00	0.00
CHLORINE	0.00	0.00	0.00	0.00
WATER	0.00	0.00	0.00	0.00
INERTS	0.00	0.00	0.00	0.00
TOTAL	100.00	1.00	1.00	100.00

FUEL RATE (TONS/DAY)	2.55
TOTAL AIR ASSIGNED (%)	129
FUEL HIGHER HEATING VALUE (BTU/LB)	23896
HEAT LOSS DUE TO UNBURNED CARBON (%)	0.00
CARBON IN RESIDUE (%)	0.00
EXIT GAS TEMPERATURE (Deg. F)	333
AMBIENT DRY BULB TEMP (Deg.F)	80
HUMIDITY RATIO (LBS H2O/LB DRY AIR)	0.0132
BAROMETRIC PRESSURE (IN.Hg.)	29.92
RADIATION LOSS (%)	0.00
UNACCOUNTABLE LOSS (%)	0.00
ENTHALPY ADDED IN BOILER (BTU/LB)	985

FANS

	STAT.PRES (IN.H2O)	EFFICIENCY (%)	AIR SUPPLIED (% TOT.)	TEST BLOCK FLOW (%)	TEST BLOCK STATIC (%)
PRIMARY	5.0	82.0	100	10	20
SECONDARY	0.0	82.0	0	20	44
INDUCED DRAFT	0.0	85.0		25	56

COMBUSTION CALCULATIONS

OUTPUT

CLIENT: RSH

DATE: Apr 4,1996

PLANT: PINE BLUFF ARSENAL
Bldg.44-120,30 psig ,1.6% Stack O2,333 EGT

TIME: 05:46 PM

HEAT LOSSES	MBTU /HR	PERCENT
IN DRY FLUE GAS	0.28	5.44
FROM H2O IN AIR	0.01	0.14
FROM H20 IN FUEL--SENSIBLE	0.05	1.07
FROM H20 IN FUEL--LATENT	0.49	9.72
TOTAL IN WET FLUE GAS	0.83	16.37
DUE TO UNBURNED CARBON	0.00	0.00
DUE TO HOT ASH	0.00	0.00
DUE TO RADIATION & UNACCOUNTABLE	0.00	0.00
TOTAL	0.83	16.37

BOILER EFFICIENCY (%)	83.63
STEAM GENERATED (LBS/HR)	4312
UNBURNED CARBON (LBS/HR)	0
LBS OF WET FLUE GAS PER LB FUEL	23.52
SPEC.VOL.OF WET FLUE GAS (CU.FT./LB)	20.81
AIR TO FUEL RATIO (LB AIR/LB FUEL)	22.23
COMB. AIR SPECIFIC VOL. (CU.FT/LB)	13.712
COMBUSTION AIR FLOW (LBS/HR)	4785

FLUE GAS ANALYSIS

	% BY VOLUME		% BY WEIGHT	
	WET	DRY	WET	DRY
CO2	7.38	8.85	11.68	13.09
SO2	0.0000	0.0000	0.0000	0.0000
O2	4.30	5.15	4.95	5.54
HCL	0.0000	0.0000	0.0000	0.0000
N2	71.73	86.00	72.62	81.37
H2O	16.59		10.75	

COMBUSTION CALCULATIONS
OUTPUT

CLIENT: RSH

DATE: Apr 04,1996

PLANT: PINE BLUFF ARSENAL
Bldg.44-120,30 psig ,1.6% Stack O2,333 EGT

TIME: 5:46 PM

FLUE GAS FLOWS

	WET	DRY
MASS (LBS/HR)	4998	4461
VOLUME (ACFM)	1733	1446
(SCFM)(70DEG.F.)	1159	966
@ 12% CO2	1883	1310
"F" FACTOR (DSCF/MMBTU @12% CO2)		15486

FAN DATA

	NET			TEST BLOCK		
	LBS/HR	ACFM	BHP	LBS/HR	ACFM	BHP
PRIMARY	4785	1094	1.05	5264	1203	1.38
SECONDARY	0	0	0	0	0	0
INDUCED	4998	1733	0	6247	2167	0

COMBUSTION CALCULATIONS

INPUT

CLIENT: RSH

DATE: Apr 4,1996

PLANT: PINE BLUFF ARSENAL
York Shipley,125 psig ,10%Excess Air,413 EGT

TIME: 06:10 PM

FUEL ULTIMATE ANALYSIS

CONSTITUENT	WT.PCT.	RECEIVED	DRY & ASH FREE	ADJUSTED/ AS FIRED
CARBON	75.00	0.75	0.75	75.00
HYDROGEN	25.00	0.25	0.25	25.00
OXYGEN	0.00	0.00	0.00	0.00
NITROGEN	0.00	0.00	0.00	0.00
SULFUR	0.00	0.00	0.00	0.00
CHLORINE	0.00	0.00	0.00	0.00
WATER	0.00	0.00	0.00	0.00
INERTS	0.00	0.00	0.00	0.00
TOTAL	100.00	1.00	1.00	100.00

FUEL RATE (TONS/DAY)	12.23
TOTAL AIR ASSIGNED (%)	110
FUEL HIGHER HEATING VALUE (BTU/LB)	23896
HEAT LOSS DUE TO UNBURNED CARBON (%)	0.00
CARBON IN RESIDUE (%)	0.00
EXIT GAS TEMPERATURE (Deg. F)	413
AMBIENT DRY BULB TEMP (Deg.F)	80
HUMIDITY RATIO (LBS H2O/LB DRY AIR)	0.0132
BAROMETRIC PRESSURE (IN.Hg.)	29.92
RADIATION LOSS (%)	0.00
UNACCOUNTABLE LOSS (%)	0.00
ENTHALPY ADDED IN BOILER (BTU/LB)	1005

FANS

	STAT.PRES (IN.H2O)	EFFICIENCY (%)	AIR SUPPLIED (% TOT.)	TEST BLOCK FLOW (%)	TEST BLOCK STATIC (%)
PRIMARY	5.0	82.0	100	10	20
SECONDARY	0.0	82.0	0	20	44
INDUCED DRAFT	0.0	85.0		25	56

COMBUSTION CALCULATIONS

OUTPUT

CLIENT: RSH DATE: Apr 4,1996

PLANT: PINE BLUFF ARSENAL TIME: 06:10 PM

York Shipley,125 psig ,10%Excess Air,413 EGT

HEAT LOSSES	MBTU /HR	PERCENT
IN DRY FLUE GAS	1.49	6.13
FROM H2O IN AIR	0.04	0.16
FROM H20 IN FUEL--SENSIBLE	0.35	1.42
FROM H20 IN FUEL--LATENT	2.37	9.72
TOTAL IN WET FLUE GAS	4.24	17.43
DUE TO UNBURNED CARBON	0.00	0.00
DUE TO HOT ASH	0.00	0.00
DUE TO RADIATION & UNACCOUNTABLE	0.00	0.00
TOTAL	4.24	17.43

BOILER EFFICIENCY (%)	82.57
STEAM GENERATED (LBS/HR)	20000
UNBURNED CARBON (LBS/HR)	0
LBS OF WET FLUE GAS PER LB FUEL	20.18
SPEC.VOL.OF WET FLUE GAS (CU.FT./LB)	23.03
AIR TO FUEL RATIO (LB AIR/LB FUEL)	18.93
COMB. AIR SPECIFIC VOL. (CU.FT/LB)	13.712
COMBUSTION AIR FLOW (LBS/HR)	19535

FLUE GAS ANALYSIS

	% BY VOLUME		% BY WEIGHT	
	WET	DRY	WET	DRY
CO2	8.56	10.56	13.62	15.53
SO2	0.0000	0.0000	0.0000	0.0000
O2	1.71	2.11	1.98	2.26
HCL	0.0000	0.0000	0.0000	0.0000
N2	70.83	87.34	72.09	82.21
H2O	18.90		12.31	

COMBUSTION CALCULATIONS

OUTPUT

CLIENT: RSH   DATE: Apr 04,1996

PLANT: PINE BLUFF ARSENAL   TIME: 6:10 PM
York Shipley,125 psig ,10%Excess Air,413 EGT

FLUE GAS FLOWS

	WET	DRY
MASS (LBS/HR)	20554	18023
VOLUME (ACFM)	7890	6399
(SCFM)(70DEG.F.)	4790	3885
@ 12% CO2	6714	4416
"F" FACTOR (DSCF/MMBTU @12% CO2)		10884

FAN DATA

	NET			TEST BLOCK		
	LBS/HR	ACFM	BHP	LBS/HR	ACFM	BHP
PRIMARY	19535	4464	4.28	21489	4911	5.65
SECONDARY	0	0	0	0	0	0
INDUCED	20554	7890	0	25693	9863	0

A.4 STEAM LEAK ENERGY LOSS CALCULATIONS

P6A Natural Gas Balance														
Nat. Gas Bal. (MBtu/Mo)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total MBtu/yr	Total Cost
Natural Gas Bills (1)	72,425	85,186	56,220	47,655	37,697	38,392	37,636	34,199	35,284	41,937	56,597	77,672	805,262	$1,700,642
Buildings w/ Meters (2)	9,167	10,262	7,633	5,274	2,505	3,814	5,233	5,277	4,505	6,078	6,715	9,387	75,872	$213,200
Process Heat (3)	10,181	10,647	12,178	10,759	10,907	11,846	12,357	10,382	10,034	10,161	9,653	10,544	129,649	$364,875
Condensate Losses (4)	4,226	3,889	3,362	2,847	2,353	2,312	2,160	1,934	2,056	2,397	3,469	4,567	35,395	$99,460
Conduction Losses (5)	4,584	4,080	4,392	4,118	4,138	3,890	3,971	3,884	3,947	4,234	4,266	4,530	50,114	$140,621
Comfort Heating (6)	35,117	27,788	20,787	6,854	2,517	271	73	137	1,322	7,812	16,317	30,367	151,362	$425,382
Steam Leaks (7)	9,148	6,700	9,849	18,005	15,277	18,257	14,024	12,505	13,417	11,234	15,977	18,278	182,671	$457,105
														$1,700,842
	(1)	Monthly natural gas bills for entire Arsenal from Falling Tree Enterprises.												
	(2)	Monthly totals from the 71 metered buildings at P8A, see attached table.												
	(3)	See Process Energy Use Calculations.												
	(4)	Assumes:	10%	of condensate is returned, TC =			120 °F	TGW =	88 °F	Boiler eff =	70%			
	(5)	See Conduction Loss Calculations.												
	(8)	See Comfort Heating Calculations - 6in Temperature Method.												
	(7)	Steam leaks (7) = (1) - (2) - (3) - (4) - (5) - (6)												
P6A Natural Gas Balance - Corrected														
Corr. N.G. Bal. (MBtu/Mo)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total MBtu/yr	Total $
Natural Gas Bills	72,425	65,166	56,220	47,655	37,697	38,392	37,638	34,199	35,284	41,937	56,597	77,672	605,262	$1,700,642
Bldgs w/ Meters	9,187	10,282	7,833	5,274	2,505	3,814	5,233	5,277	4,505	6,079	6,715	8,387	75,672	$213,200
Process Heat	10,181	10,647	12,176	10,759	10,907	11,846	12,357	10,382	10,034	10,161	9,853	10,544	129,649	$384,675
Condensate Losses	4,226	3,689	3,362	2,647	2,353	2,312	2,160	1,934	2,056	2,397	3,469	4,567	35,395	$99,480
Conduction Losses	4,584	4,080	4,392	4,116	4,136	3,890	3,971	3,984	3,947	4,234	4,266	4,530	50,114	$140,621
Comfort Heating (6)	32,853	24,499	20,202	12,196	2,517	271	73	137	394	5,473	21,497	37,920	158,031	$444,087
Steam Leaks	11,412	11,989	10,434	12,682	15,277	16,257	14,024	12,505	14,346	13,572	12,797	10,745	156,021	$436,420
														$1,700,642
Comfort Heating Correction Calculations (actual weather was not the same as the bin data)														
Space Heat w/ Summer = 0 (9)	32,853	24,499	20,202	12,196	4,807	4,193	2,220	(1,483)	394	5,473	21,497	37,920		
Calculated Corr. Values (10)	2,284	3,289	585	(5,342)	(2,290)	(3,922)	(2,147)	1,800	828	2,339	(3,180)	(7,533)		
Comfort Heat Corr. Values (11)	2,264	3,289	585	(5,342)	0	0	0	0	928	2,339	(3,180)	(7,533)		
	(8)	Calculated Comfort Heating (8) - Comfort Heat Corr. Value (11)												
	(9)	Current Month Nat. Gas Use (1) - Aug Nat. Gas Use (1) - (Current metered bldgs use (2) - Jun metered bldgs use(2))												
	(10)	Calculated Comfort Heating (8) - Space Heat w/ Summer = 0 (9)												
	(11)	Values from item (10) for heating months only.												

PINE BLUFF ARSENAL

1995 Monthly Gas Meter Readings

GROUP 1 BUILDINGS

Bldg No.	32100	32070	32090	32130	32035	33080	23390	23330	23310	23370	24770	24610	17120	17110	17130		13130	13050	13060	13090	13100	13005	13060	13020		Sub Total
Bldg. Name		Laundry						Supply	LCL	E&T	PDO	Union & Jan Serv.	Moody School Contrac	Moody School Pub. Aff.	Moody School Person.	NCO Capehart			Lab	Training Ofc.					Club & BOQ-Staff Row	Group 1 Buildings
25-Jan-95	224	200	128	27	261	18	1	636	178	62	10	28	79	28	37	500	12	11	51	20	25	6	15	37	153	2747
25-Feb-95	225	186	105	31	341	17	1	623	193	52	11	29	24	30	49	467	39	13	71	43	44	12	62	68	97	2633
25-Mar-95	133	192	49	11	160	8	0	448	88	26	6	15	10	17	17	331	16	213	28	21	18	4	19	24	47	1909
25-Apr-95	44	234	3	1	22	3	0	198	26	11	0	2	2	3	12	187	2	20	3	6	4	1	6	8	39	837
25-May-95	20	170	3	0	14	1	0	95	17	3	0	1	1	1	2	156	3	9	4	8	0	0	4	0	29	541
25-Jun-95	1	204	1	0	3	0	1	11	3	1	0	1	1	0	0	81	2	4	2	0	0	1	0	0	29	346
25-Jul-95	1	249	1	0	3	0	0	5	3	1	0	1	1	0	3	79	2	3	2	1	0	0	0	0	32	387
25-Aug-95	1	176	1	0	4	0	0	4	3	2	0	1	0	0	2	82	2	2	2	0	0	0	0	0	28	310
25-Sep-95	3	189	1	0	3	1	0	26	4	2	0	1	1	0	2	93	2	4	1	0	0	0	0	0	42	377
25-Oct-95	28	322	2	0	4	0	1	128	6	9	0	201	1	1	2	141	3	8	2	3	0	1	1	1	98	963
25-Nov-95	73	137	45	3	102	8	1	354	95	30	7	15	5	20	16	284	11	57	15	15	3	2	14	16	146	1476
25-Dec-95	231	140	99	23	274	16	1	516	301	63	11	30	24	42	44	429	21	112	49	31	10	10	30	43	186	2736

GROUP 2 BUILDINGS

Bldg No.	10050		10020	810030		12410	50610	54010	57160	51570	51570	53100	93500	53160	51420	60090	60400	60060	60070	63120	63010	63110	63200	63220	63410	Sub Total
Bldg. Name	Fire Station	Staff Row	Admin. Bldg.	SRT & Environ.	Farm Hse & Ofcr Capehart	Farm house	BZ Plant Warehse		6Z Plant Ofc		DMMD Portion				Halfway house	Traffic	DMMD Carp. Shop				Dock					Group 2 Buildings
25-Jan-95	117	145	266	59	143	36	35	0	20	43	150	70	52	21	75	8	127	24	121	217	44	26	90	111	110	2110
25-Feb-95	102	163	244	104	149	25	29	0	26	50	430	81	74	9	72	20	217	63	104	268	70	110	141	340	145	3036
25-Mar-95	71	98	190	53	97	14	2	0	14	34	171	44	35	33	44	8	114	23	50	120	37	59	58	114	86	1569
25-Apr-95	36	50	6	15	57	6	2	0	5	23	95	21	17	17	2	3	11	7	20	39	23	2	9	37	62	567
25-May-95	24	30	2	7	46	4	2	0	3	20	65	5	11	3	2	3	7	3	17	17	16	1	2	11	39	340
25-Jun-95	14	12	0	4	29	3	2	0	0	8	16	1	1	3	1	3	3	0	6	1	1	1	1	1	39	150
25-Jul-95	14	12	0	4'	26	3	2	0	0	8	13	0	1	3	1	3	4	2	4	1	0	1	1	0	39	142
25-Aug-95	14	13	0	4	29	3	2	0	0	8	13	0	1	4	2	3	4	1	4	1	0	1	1	0	37	145
25-Sep-95	16	16	1	5	34	1	2	0	0	10	15	0	1	1	3	3	5	1	4	17	0	0	1	10	39	165
25-Oct-95	31	27	2	9	48	1	2	1	1	22	27	1	1	5	3	3	16	7	8	36	0	5	6	14	53	331
25-Nov-95	65	93	184	35	79	23	2	6	12	50	47	25	45	27	15	5	100	21	26	164	0	94	37	68	53	1316
25-Dec-95	116	153	264	62	142	21	166	11	29	49	223	62	68	56	40	15	152	44	105	220	48	142	105	176	195	2666

GROUP 3 BUILDINGS

Bldg No.	60120	16140	16076	16175	16190	16210	16220	16230	16250	16270	16340	16310	16440	34960	34910	44101	44300	42965	42970	42930	34121	Sub Total
Bldg. Name			Pool	Day Care							PX	Rec. Cntr.	Cred. Union				Dlly Farm		Incin.	CWT	Gate 6	Group 3 Buildings
25-Jan-95	26	51	0	14	67	35	22	21	14	22	4	165	16	7	12	6	0	26	3,711	77	10	4,330
25-Feb-95	51	54	0	4	113	66	56	39	23	24	5	162	10	15	15	7	0	24	3,711	22	10	4,413
25-Mar-95	17	40	0	6	67	42	22	16	11	47	2	99	9	5	16	9	0	22	3,711	12	2	4,155
25-Apr-95	2	14	0	2	33	20	20	5	4	17	2	15	2	1	6	1	0	9	3,711	2	2	3,870
25-May-95	0	6	0	0	7	4	7	6	1	2	2	12	0	1	2	0	0	9	1,558	5	2	1,624
25-Jun-95	0	2	2	0	23	4	4	5	0	2	2	33	0	0	10	0	0	3	3,227	1	0	3,318
25-Jul-95	0	3	1	0	22	5	3	4	0	1	2	18	0	0	7	0	0	3	4,633	2	0	4,704
25-Aug-95	0	3	1	0	17	5	1	5	0	1	2	31	0	0	6	0	0	2	4,745	2	1	4,822
25-Sep-95	0	3	1	0	16	5	9	5	0	1	2	10	0	0	8	0	0	5	3,873	2	1	3,943
25-Oct-95	1	3	1	0	16	5	14	6	2	1	2	16	0	3	10	0	0	10	4,687	2	2	4,785
25-Nov-95	17	32	0	5	66	21	3	32	12	3	2	55	6	10	6	5	14	22	3,593	9	4	3,923
25-Dec-95	43	67	0	10	111	39	22	36	22	30	9	70	15	13	9	6	27	28	3,374	23	9	3,965

TOTALS

Sub Total Group 1 Buildings (above)	Sub Total Group 2 Buildings (above)	Sub Total Group 3 Buildings (above)	Sub Total Sum of All Meters	PBA Total 1995 Gas Bills (MBTU)	Boilers Areas 31, 32, 33, 34, 44
2747	2110	4,330	9,187	72,425	63,238
2833	3036	4,413	10,282	65,166	54,884
1909	1569	4,155	7,633	58,220	50,587
837	567	3,870	5,274	47,855	42,581
541	340	1,624	2,505	37,697	35,192
346	150	3,318	3,814	38,392	34,578
387	142	4,704	5,233	37,838	32,605
310	145	4,822	5,277	34,199	28,922
377	165	3,943	4,505	35,284	30,779
963	331	4,785	6,079	41,937	35,858
1476	1316	3,923	6,715	58,597	51,882
2736	2666	3,965	9,367	77,672	68,305
			75,872	605,262	529,410

Process Energy Use Calculations													
	Steam	N. Gas											
Natural Gas Demand - Calcs	lbs/hr	MBtu/hr											
	(1)	(2)	NOTES:										
Process Area 31 (3)	375	0.54	(1)	From 1994 CDG Utility Study updated by PBA Production staff.									
Process Area 32 (3)	637	0.91	(2)	Assumes 1000 Btu/lb of steam, boiler efficiency = 70% for areas 32, 33 & 34 and 80% for area 44.									
Process Area 33 (3)	75	0.11	(3)	Assumes the production operating level is:				50%	of maximum capacity.				
Area 34 Operational (4)	21158	30.23	(4)	Assumes WP production operating level is:				50%	of maximum capacity.				
Area 34 Stand By (5)	8463	12.09	(5)	Assumes WP stand-by energy use level is:				40%	of maximum capacity.				
Process Area 44	33	0.04	(6)	From The Weather Almanac, Fourth Edition, 30 year average monthly temperatures.									
Totals	30,741	43.91	(7)	From WP Production Schedule dated March 6, 1996.									
			(8)	N. Gas MBtu/hr x Oper. Hrs/Mo + Stand-by N. Gas x (Total Hours/Month - Oper. Hrs/Mo)									
			(9)	N. Gas MBtu/hr x Total Hours/Month									
Operating and Weather Data													
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Totals
Average OA Temp. (6)	41.4	44.6	53	62.4	70.2	78.2	81.5	80.6	74.2	63.7	51.9	43.7	
Days per month	31	28	31	30	31	30	31	31	30	31	30	31	365
Total Hours/Month	744	672	744	720	744	720	744	744	720	744	720	744	8760
Area 34 Op. Hrs/Mo (7)	0	80	110	50	40	110	120	10	10	0	0	20	550
Process Energy (MBtu/Mo)													
Area 34 (8)	8995	9576	10990	9612	9721	10700	11172	9177	8887	8995	8705	9358	115,887
Area 31 (9)	399	360	399	386	399	386	399	399	386	399	386	399	4,693
Area 32 (9)	677	611	677	655	677	655	677	677	655	677	655	677	7,969
Area 33 (9)	80	72	80	77	80	77	80	80	77	80	77	80	939
Area 44 (9)	31	28	31	30	31	30	31	31	30	31	30	31	361
Total Process Heating	10,181	10,647	12,176	10,759	10,907	11,848	12,357	10,362	10,034	10,181	9,853	10,544	129,849

EXHIBIT F
STEAM DEMAND FOR MOBILIZATION CONDITION

CDG UTILITY STUDY

EQUIPMENT EFFECTIVNESS FACTOR %

STEAM DEMANDS

PINE BLUFF ARSENAL, ARKANSAS
DEPARTMENT OF THE ARMY

BUILDING NUMBER	BLDG USE	VENILATION CFM	HEATING LOAD LBS STEAM/HR	CURRENT DEMAND STEAM PROCESS LOAD LBS STEAM/HR	TOTAL LOAD LBS STEAM/HR	PARTIAL BASELINE EMERGENCY STEAM PROCESS LOAD LBS STEAM/HR	TOTAL LOAD LBS STEAM/HR	BASELINE EMERGENCY STEAM PROCESS LOAD LBS STEAM/HR	TOTAL LOAD LBS STEAM/HR
31080	ELECTRONIC CALIBRATION FACILITY		349.99		349.99		349.99		349.99
31100	MAINT FACILITY		1,730.12		1,730.12		1,730.12		1,730.12
31150	PRODUCTION OFFICE		248.92		248.92		248.92		248.92
31310	RAW MAT. WAREHOUSE		1,837.00		1,837.00		1,837.00		1,837.00
31330	RAW MAT. WAREHOUSE		1,837.00		1,837.00		1,837.00		1,837.00
31420	RAW MAT. WAREHOUSE		1,837.00		1,837.00		1,837.00		1,837.00
31440	RAW MAT. WAREHOUSE		1,837.00		1,837.00		1,837.00		1,837.00
31520	MIX BUILDING	15,290	2,005.00		2,005.00		2,005.00		2,005.00
31530	FILL AND PRESS	29,010	3,728.00	750 750	✓ 4,478.00	1500	5,228.00	1500	5,228.00
31531	OFFICE AND RESTROOMS		239.26		239.26		239.26		239.28
31540	DOWNLOAD FACILITY		947.03		947.03		947.03		947.03
31570	MUNITIONS STORAGE		1,187.97		1,187.97		1,187.97		1,187.97
L 31620	PYRO MIX BLDG (THERMATE MIX)	14,860	0 1,949.00	0 20	1,969.00	20	1,969.00	20	1,969.00
L 31630	FILL AND PRESS	10,000	0 2,852.19	0 300	3,152.19	0	2,852.19	500	3,352.19
31631	BREAK AND RESTROOMS		239.26		239.26		239.26		239.26
31640	ASSEMBLY		947.03		947.03		947.03		947.03
31670	STORAGE		1,187.97		1,187.97		1,187.97		1,187.97
L 31720	PYROTECHNIC PRODUCTION	2,870	0 454.00	0 100	554.00	100	554.00	100	554.00
31730	STORAGE		149.86		149.86		149.86		149.86
31820	STORAGE		301.43		301.43		301.43		301.43
31830	AMMO QUAL FAC		149.86		149.86		149.86		149.88
31860	STORAGE		159.50		159.50		159.50		159.50
			20919 26,174.42	750 1,170.00	27,344.42	1,620.00	27,794.42	2,120.00	28,294.42
32000	CAFETERIA		512.16		512.16		512.16		512.16
32030	INSPECTION GARAGE		706.04		706.04		706.04		706.04
32035	ORDINANCE SHOP		0.00		0.00		0.00		0.00
32070	IMPREG AND LAUNDRY		1,909.25	93	2,002.25	93	2,002.25	93	2,002.25
32080	MHE BATTERY SHOP		349.99		349.99		349.99		349.99
32090	WAREHOUSE		855.31		855.31		855.31		855.31
32100	ELECTRONIC CALIBRATION FACILITY		1,730.12		1,730.12		1,730.12		1,730.12
32130	AMMO QUAL FAC		561.96		561.96		561.96		561.96
32150	AMMO QUAL FAC		248.92		248.92		248.92		248.92
32230	FILTER BLDG		1,628.91		1,628.91		1,828.91		1,628.91
32270	WAREHOUSE		1,628.91	0	1,628.91	0	1,628.91	0	1,628.91
32310	RAW MAT. WAREHOUSE		1,837.00		1,837.00		1,837.00		1,837.00
32330	RAW MAT. WAREHOUSE		1,837.00		1,837.00		1,837.00		1,837.00
32420	RAW MAT. WAREHOUSE		1,837.00		1,837.00		1,837.00		1,837.00
32440	EQUIPEMENT WAREHOUSE		1,837.00		1,837.00		1,837.00		1,837.00
32510	PROD ENGR LAB		518.13		518.13		518.13		518.13
32520	PROD ENGR LAB		1,067.96		1,067.96		1,067.98		1,067.98
32530	FORMER BZ FACILITY		2,543.52		2,543.52		2,543.52		2,543.52
32531			151.46		151.46		151.46		151.48

A.4-4

CDG UTILITY STUDY

EXHIBIT F
STEAM DEMAND FOR MOBILIZATION CONDITION

EQUIPMENT EFFECTIVNESS FACTOR %

STEAM DEMANDS

PINE BLUFF ARSENAL, ARKANSAS
DEPARTMENT OF THE ARMY

BUILDING NUMBER	BLDG USE	VENILATION CFM	HEATIING LOAD LBS STEAM/HR	CURRENT DEMAND STEAM PROCESS LOAD LBS STEAM/HR	TOTAL LOAD LBS STEAM/HR	PARTIAL BASELINE EMERGENCY STEAM PROCESS LOAD LBS STEAM/HR	TOTAL LOAD LBS STEAM/HR	BASELINE EMERGENCY STEAM PROCESS LOAD LBS STEAM/HR	TOTAL LOAD LBS STEAM/HR
32540	FORMER BZ FACILITY		947.03		947.03		947.03		947.03
32550	AMMO QUAL FAC		353.92		353.92		353.92		353.92
32570	OPERATIONS GENERAL PURPOSE		1,209.30		1,209.30		1,209.30		1,209.30
32610	DRYING	14,900	1,705.00	7.26	1,712.26	7.26	1,712.26	7.26	1,712.26
32620	COLORED SMOKE MIX (GLATT)	15,290	2,005.00	100% OA 436	2,441.00	872	2,877.00	872	2,877.00
32630	STORAGE		1,673.76		1,673.76		1,673.76		1,673.76
32631	OFFICE AND RESTROOMS		239.26		239.26		239.26		239.26
32640	PYROTECHNIC PRODUCTION	12,510	2,206.10	100	2,206.10		2,206.10		2,206.10
32670	SUU-7 TEST		1,187.97		1,187.97		1,187.97		1,187.97
32720	PROD ENGR LAB		418.58		418.58		418.58		418.58
32730	PROD ENGR LAB		173.74		173.74		173.74		173.74
32820	MATERIAL STORAGE		301.43		301.43		301.43		301.43
32830	MATERIAL STORAGE		149.86		149.86		149.88		149.88
32860	STORAGE		159.50		159.50		159.50		159.50
			34,491.10	636 536.26	35,027.36	972.26	35,463.36	972.26	35,463.36
33080	SAFETY EQUIP		349.99		349.99		349.99		349.99
33100	CHANGE HOUSE		1,730.12		1,730.12		1,730.12		1,730.12
33150	PRODUCTION		248.92		248.92		248.92		248.92
33310	RAW MAT. WAREHOUSE		1,837.00		1,837.00		1,837.00		1,837.00
33330	RAW MAT. WAREHOUSE		1,837.00		1,837.00		1,837.00		1,837.00
33420	RAW MAT. WAREHOUSE		1,837.00		1,837.00		1,837.00		1,837.00
33440	RAW MAT. WAREHOUSE		1,837.00		1,837.00		1,837.00		1,837.00
33520	MIX BUILDING	16,610	1,944.00		1,944.00		1,944.00		1,944.00
33530	FILL AND PRESS	26,900	4,675.86	50	4,725.86	50	4,725.86	50	4,725.86
33531	PUBLIC TOILET		239.26		239.26		239.26		239.26
33540	STORAGE		948.37		948.37		948.37		948.37
33550	IN PROCESS STORAGE		388.02		388.02		388.02		388.02
33570	LAP		1,187.97	0	1,187.97	0	1,187.97	0	1,187.97
33620	STARTER MIX BUILDING		1,067.98	100	1,167.96	100	1,167.98	100	1,167.96
33630 (L)	FILL AND PRESS	10,000	0 2,420.61	0	2,420.61	300	2,720.61	300	2,720.61
33631	OFFICE AND RESTROOMS		239.26		239.26		239.26		239.26
33640	ASSEMBLY BUILDING		947.03		947.03		947.03		947.03
33650	IN PROCESS STORAGE		353.92		353.92		353.92		353.92
33670	M116 LAP		1,187.97		1,187.97		1,187.97		1,187.97
33720	KC103 PROP		301.43		301.43		301.43		301.43
33730	QC TEST FAC		149.86		149.86		149.86		149.86
33820	STARTER MIX SLUGS		301.43		301.43		301.43		301.43
33830	COMPONENT STORAGE		149.86		149.86		149.86		149.86
33860	STORAGE IGLOO		159.50		159.50		159.50		159.50
			23919 26,339.36	150 150.00	26,489.36	450.00	28,789.36	450.00	26,789.38

A.4-5

EXHIBIT F
STEAM DEMAND FOR MOBILIZATION CONDITION

CGD UTILITY STUDY

EQUIPMENT EFFECTIVNESS FACTOR %

STEAM DEMANDS

PINE BLUFF ARSENAL, ARKANSAS
DEPARTMENT OF THE ARMY

BUILDING NUMBER	BLDG USE	VENILATION CFM	HEATIING LOAD LBS STEAM/HR	CURRENT DEMAND STEAM PROCESS LOAD LBS STEAM/HR	TOTAL LOAD LBS STEAM/HR	PARTIAL BASELINE EMERGENCY STEAM PROCESS LOAD LBS STEAM/HR	TOTAL LOAD LBS STEAM/HR	BASELINE EMERGENCY STEAM PROCESS LOAD LBS STEAM/HR	TOTAL LOAD LBS STEAM/HR
34110	WP FILLING	139,310	16,957.00	10602.42	27,559.42	14136.56	31,093.58	14136.56	31,093.56
34120	AMMO QUAL FAC		1,221.45		1,221.45		1,221.45		1,221.45
34130	WP UNLOAD TANKS		474.95	7555.06	8,030.01	7555.06	8,030.01	7555.06	8,030.01
34170	WP BULK STORAGE			21659.27	21,659.27	21659.27	21,659.27	21659.27	21,659.27
34350	ASSEMBLY AND PACKOUT		879.89		879.89		879.89		879.89
34370			331.19		331.19		331.19		331.19
34420			319.82		319.82		319.82		319.82
34430	RAW MATERIAL WAREHOUSE		1,861.28		1,861.28		1,861.28		1,861.28
34620			1,768.37		1,768.37		1,768.37		1,768.37
34630	PYROTECHNIC PRODUCTION	8,000	2,270.12	1200	3,470.12	1200	3,470.12	1200	3,470.12
34640	HC MIX	57,820	5,761.00	1200	5,761.00		5,761.00		5,761.00
34650	START MIX SLEEVE		1,369.83	100	1,369.83		1,369.83		1,369.83
34660	SUB ASSEMBLY		328.47		326.47		326.47		326.47
34820	STORAGE		159.50		159.50		159.50		159.50
34910	FE MAINTENANCE SHOP		9,632.65		9,632.65		9,632.65		9,632.65
34970	ADMIN BUILDING		451.97		451.97		451.97		451.97
			43,785.48	42317 41,016.75	84,802.23	44,550.89	88,336.37	44,550.89	88,336.37
42960	GRENADE TEST BUILDING		421.00		421.00		421.00		421.00
44110	LAP		3,957.49	33	3,990.49	33	3,990.49	33	3,990.49
			135,168.85	42,906.01	178,074.86	47,626.15	182,795.00	48,126.15	183,295.00
			127493	43886					

A.4-6

4). Additional production lines could be constructed in the same facility or in existing nearby facilities.

5). Load, Assemble, and Pack (LAP) facilities can accommodate the desired production levels as specified by the three mobilization conditions.

6). Production rates are constant. It may be possible to increase production rates.

Monthly production capacity was compared to desired mobilization schedules for each chemical munitions/product per mobilization condition. If the monthly production capacity (summation of all production lines per munition) cannot meet or exceed the desired production (per mobilization condition), then additional production lines were assumed to be constructed and placed on line.

The following exhibit entitled "Required Monthly Production Capacity to Meet Mobilization Production Demands" lists all chemical munitions/products in the mobilization plan, and shows the effects of each production facility in terms of number of shifts and production lines required to fulfill each mobilization condition. (See Exhibit C)

C. STEAM DEMAND ANALYSIS:

The steam demand analysis consist of two portions: a) the building heat loads; and b) the process steam requirements per mobilization condition. Steam demand is calculated in pounds of steam per hour (lbs steam/hr).

1). Building Heat Loads: All of the steam and compressed air lines were visually inspected and video taped. In the course of video taping, all buildings with connections to the steam and compressed air lines were also video taped. This information was used to aid in compiling a basic inventory of the buildings within the production areas that require comfort heating. The area (footprint) of each building and the building construction composition was obtained from existing Pine Bluff Arsenal records. Ventilation requirements, if necessary, were obtained from Pine Bluff Arsenal engineering staff. Additional information concerning ventilation has been requested from Pine Bluff Arsenal engineering staff. All of this information was compiled in a spreadsheet format "data base". This data base was then sorted into similar building types. There are 51 distinct building types within all of the production areas in the scope of this study. See Exhibit D for a listing of all buildings within the study area that are served by steam and compressed air.

The steam plant buildings have been omitted from this listing because it was assumed that these buildings can easily be heated with "waste" heat from the plants.

Heating loads were calculated based on an outside temperature of 0° F and an inside temperature of 70° F. The inside temperature of 70° F is in accordance with Pine Bluff Arsenal design guidelines. The temperature of 0° F was selected in order to adequately model the possibility that a maximum mobilization condition could occur in the winter months. The Pine Bluff Arsenal engineers directed that all heating calculations be performed at 0°F. The industry standard (American Society for Heating, Refrigeration and Air Conditioning Engineers [ASHRAE]) for this area is 22°F. The following exhibits list all buildings requiring comfort heating (with the exclusion of steam plants), the associated heat loads in Btu's per hour (Btu/hr), and pounds of steam per hour (lbs steam/hr). An equipment effectiveness factor[3] of 30% has been included in the heating load stated in lbs. steam/hr. This heat load is used for all three mobilization conditions. See Exhibit E - Building Heat Loads.

The heating load is increased by approximately 46% for calculations based on 0° F rather than 22°F.

2). Process Steam Demands: Process steam demands were obtained and/or calculated for each production line (either existing or proposed). Process steam loads were then prepared per mobilization condition.

The following assumptions were made:

a). Steam demands were calculated based on the assumption that all chemical munitions/products are being produced simultaneously, at maximum levels.

b). Protective mask rebuild production occurs in Buildings 63-100 and 63-101. This product does not require any process steam.

The following exhibit illustrates the steam demands for each building for the three mobilization conditions by production area (see Exhibit F). Total steam demand per building was calculated by adding the building heat load (lbs steam/hr) to the process steam load (lbs steam/hr). It was assumed that there is no waste process heat available to heat the building.

D. COMPRESSED AIR ANALYSIS:

Compressed air demand was compiled primarily through interviews with Pine Bluff Arsenal engineering staff, and in some cases by calculation and engineering judgement. The following assumptions were made:

1). All chemical munitions/products are being produced simultaneously.

[3] *Equipment effectiveness factor represents the expected heat loss due to ineffectiveness of heating apparatus such as steam coils and line losses.*

RS&H	SUBJECT: WP Energy Use	AEP NO: 694 1331 004	
	DESIGNER: W. Todd	SHEET:	OF:
	CHECKER:	DATE: 6-12-96	
		DATE:	

Estimate Steam Demand for WP Area:

Bldg No.	Building Name	Max. lb/hr	Oper. lb/hr	Std.by lb/hr
34110	WP Filling	10600 (1)	10600 (2)	8480 (5)
34130	WP Unload Tanks	7550	750 (3)	-0- (6)
34170	WP Bulk Storage	21660	6500 (4)	6500 (4)
34630	Pyrotechnic Prod.	1200	1200 (2)	-0- (6)
34640	HC Mix	1200	1200 (2)	-0- (6)
34650	Start Mix Sleeve	100	100 (2)	-0- (6)
	Totals	42310	20350	14980

$$\text{Oper. \%} = \frac{20350}{42310} = 48.1\% \Rightarrow \text{say } 50\%$$

$$\text{Stand by \%} = \frac{14980}{42310} = 35.4\% \Rightarrow \text{say } 40\%$$

(1) From CDG Utility Study see attached copies.
(2) Assume these operations are at or near 100% utilizied.
(3) Assume this is a batch process operating 10% of the time.
(4) Assume after WP is at its production temperature, that 30% of energy is required to maintain the temperature (overcome the thermal losses)
(5) Assume 80% of energy is used during stand-by. See attached telephone call confirmation with E&T staff.
(6) Assume thess operations are shut down during stand-by.

RS&H
Reynolds, Smith and Hills, Inc.
Architectural, Engineering, Planning and Environmental Services

Telephone Call Confirmation

Date: June 12, 1996

Project Number: 694-1331-004

Project Name: PBA Electric and Heating Study

Received: **Placed:** by W. Todd

Local: **Long Dist.:** 501-540-2918

Conversed with: Pat Lawrence

of Pine Bluff Arsenal E&T Division

Regarding: Steam energy consumption for the WP area.

During the last five years the WP production building has been operating one line out of the four available lines (two wet fill and two dry fill).

During Production:

- Dry fill lines use more energy than wet fill lines.
- One-half of the leak test ovens are on only during the shift.
- WP transport pipes are kept hot.

During Stand-by (nights and weekends):

- Dry fill and wet fill cabinets kept hot.
- All of the leak test ovens are off.
- WP transport pipes are kept hot.

During Extended Stand-by (when no production for about one month):

- Almost everything will be turned off.

Distribution: PBA File By William T. Todd, PE

A.4-11

LITTLE ROCK, ARKANSAS

Normals, Means, And Extremes

Month	Normal Degree days Base 65 °F: Heating	Cooling	Precipitation in inches — Water equivalent: Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Snow, Ice pellets: Maximum monthly	Year	Maximum in 24 hrs.	Year	Relative humidity pct.: Hour 00	Hour 06	Hour 12	Hour 18 (Local time)	Wind: Mean speed m.p.h.	Prevailing direction (thru 1963)	Fastest mile: Speed m.p.h.	Direction	Year	Pct. of possible sunshine	Mean sky cover, tenths, sunrise to sunset	Mean number of days — Sunrise to sunset: Clear	Partly cloudy	Cloudy	Precipitation .01 inch or more	Snow, Ice pellets 1.0 inch or more	Thunderstorms	Heavy fog, visibility ¼ mile or less	Temperatures °F Max.: 90° and above (b)	32° and below	Min.: 32° and below	0° and below	Average station pressure mb. Elev. 285 feet m.s.l.
(a)				42		42		16		42		36		23	25	25	23	41	15	36	36			35	55	35	15	41	41	41	41	25	23	23	23	11
JAN	778	0	3.91	12.55	1950	0.75	1961	5.18	1949	12.0	1966	11.1	1960	76	80	61	64	8.7	S	44	S	1950		6.5	9	6	16	10	1	2	5	0	4	21	*	1011.7
FEB	585	0	3.83	11.02	1956	0.51	1947	5.15	1950	9.8	1979	9.6	1966	75	79	58	58	9.1	SW	57	SW	1971		6.0	9	6	15	9	1	2	2	0	1	18	0	1010.8
MAR	417	20	4.69	9.49	1955	0.73	1966	4.40	1944	7.0	1971	6.7	1971	71	78	56	58	9.9	WNW	56	SE	1959		6.2	9	7	15	10	1	5	1	*	1	8	0	1008.8
APR	124	46	5.41	10.20	1975	1.05	1960	7.96	1974	T	1983	T	1975	74	82	56	56	9.5	S	65	NW	1961		6.1	9	7	14	10	0	6	1	*	0	*	0	1006.1
MAY	18	188	5.29	12.74	1968	0.69	1970	7.71	1955	0.0		0.0		82	87	58	59	7.8	S	61	NW	1982		6.0	8	11	12	10	0	7	1	4	0	0	0	1006.3
JUN	0	405	3.67	7.82	1974	T	1952	4.61	1980	0.0		0.0		82	86	55	57	7.4	SSW	60	NE	1985		5.4	9	12	9	8	0	8	1	16	0	0	0	1005.6
JUL	0	550	3.63	7.60	1951	0.86	1942	5.41	1959	0.0		0.0		85	87	57	60	6.8	SW	56	NW	1960		5.5	8	13	9	8	0	9	1	22	0	0	0	1006.4
AUG	0	496	3.07	14.96	1966	0.19	1980	7.12	1966	0.0		0.0		85	87	56	59	6.5	SW	54	NW	1956		5.0	12	10	9	7	0	6	1	20	0	0	0	1007.2
SEP	8	287	4.26	10.17	1978	0.28	1956	4.05	1967	0.0		0.0		88	88	58	64	6.8	NE	50	NW	1952		5.2	11	9	10	7	0	4	1	9	0	0	0	1007.4
OCT	152	75	2.84	9.68	1949	0.01	1944	4.07	1949	0.0		0.0		81	85	52	62	7.0	SW	58	SSW	1956		4.5	14	8	9	6	0	2	2	2	0	*	0	1009.4
NOV	419	0	4.17	9.72	1982	0.28	1949	5.07	1957	4.8	1971	4.8	1971	78	65	58	64	8.1	SW	49	SW	1952		5.5	11	6	15	8	*	2	2	0	0	4	0	1009.8
DEC	676	0	4.25	11.56	1976	1.26	1958	5.65	1971	9.8	1965	9.8	1965	76	80	82	65	8.4	SW	46	SW	1971		6.2	9	6	16	9	1	2	2	0	2	16	*	1010.8
YEAR	3152	2045	49.20	14.96	AUG 1966	T	JUN 1952	7.96	APR 1974	12.0	JAN 1966	11.3	JAN 1960	79	65	57	60	8.0	SW	65	NW	APR 1961		5.7	119	101	145	103	2	58	16	72	7	62	*	1008.8

FOOTNOTES

Means and extremes above are from existing and comparable exposures. Annual extremes have been exceeded at other sites in the locality as follows: Highest temperature 110 in August 1936; lowest temperature -13 in February 1899; maximum monthly precipitation 18.04 in January 1937; maximum precipitation in 24 hours 8.58 in April 1913; maximum monthly snowfall 18.4 in January 1918; maximum snowfall in 24 hours 13.0 in January 1893.

(a) Length of record, years, through the current year unless otherwise noted, based on January data.
(b) 70° and above at Alaskan stations.
* Less than one half.
T Trace.
BLANK entries denote missing or unreported data.

NORMALS - Based on record for the 1951-1980 period.
MEANS - Length of record in (a) is for complete data years.
EXTREMES - Length of record in (a) may be for other than complete or consecutive data years. Date is the most recent in cases of multiple occurrence.
WIND DIRECTION - Numerals indicate tens of degrees clockwise from true north. 00 indicates calm.
FASTEST MILE WIND - Speed is fastest observed 1-minute value when direction is in tens of degrees.

NORMALS, MEANS, AND EXTREMES TABLE NOTE(S):
1. Precipitation data from Dec. 15, 1975 through Oct. 31, 1976 is from North Little Rock.
2. Wind data from Dec. 15, 1975 through Dec. 31, 1976 is from North Little Rock.
3. Maximum in 24 hours precipitation & snow; fastest mile winds; Mean sky cover & days clear-partly cloudy-cloudy are through 1977.

Heating Degree Days

Season	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	Total
1963-64	0	0	0	26	350	973	742	873	376	21	9	0	3226
1964-65	0	0	14	175	336	646	639	804	829	70	0	0	3113
1965-66	0	0	19	137	257	561	916	811	827	119	92	0	2900
1966-67	0	0	21	198	309	679	717	692	290	92	35	0	2913
1967-68	0	0	39	162	472	665	898	320	440	147	30	0	3093
1968-69	0	0	0	129	412	780	869	611	998	160	16	0	3220
1969-70	0	0	0	175	358	745	981	600	516	324	23	0	3482
1970-71	0	0	0	153	442	584	737	571	470	182	83	0	3180
1971-72	0	0	0	37	466	698	689	525	380	149	20	0	2631
1972-73	0	0	0	142	530	736	777	617	316	188	20	0	3260
1973-74	0	0	21	81	261	680	690	533	350	163	4	0	2649
1974-75	0	0	23	111	401	634	630	566	499	196	5	0	3065
1975-76	0	0	48	130	419	683	777	359	294	146	70	0	2909
1976-77	0	0	3	237	567	730	1091	502	265	70	10	0	3423
1977-78	0	0	0	107	370	709	1023	762	436	60	40	0	3623
1978-79	0	0	0	119	321	667	1033	731	319	110	13	0	3758
1979-80	0	0	0	80	436	588	645	697	450	142	15	0	3099
1980-81	0	0	16	184	437	673	774	565	388	37	45	0	3119
1981-82	0	0	12	116	278	666	887	696	298	223	6	0	3166
1982-83	0	0	12	119	349	536	795	587	425	332	33	0	3208
1983-84	0	0	19	69	422	1050							

Cooling Degree Days

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
1969	0	0	0	23	176	386	622	435	243	100	0	0	1991
1970	3	0	0	77	243	416	471	511	404	51	0	9	2194
1971	0	0	71	19	79	435	470	411	355	196	10	3	1939
1972	2	0	3	81	174	440	484	507	341	76	3	0	2111
1973	0	0	16	41	135	415	808	485	330	147	17	0	2090
1974	0	0	43	37	206	280	572	441	198	36	19	0	1787
1975	0	0	0	77	295	416	475	455	178	73	14	2	1941
1976	0	0	5	37	65	292	480	414	230	42	0	0	1602
1977	0	0	7	67	267	495	537	402	377	40	14	0	2266
1978	0	0	0	104	253	429	599	565	357	31	16	0	2358
1979	0	0	26	48	178	398	593	442	240	95	1	0	1926
1980	0	0	1	42	196	439	725	680	432	30	5	0	2474
1981	0	0	0	117	131	458	900	470	310	78	2	0	2162
1982	0	0	57	21	253	355	970	540	364	114	70	29	2289
1983	0	0	0	21	121	491	550	660	355	63	6	0	2157

Snowfall

Season	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	Total
1944-45	0.0	0.0	0.0	0.0	0.0	T	T	0.1	3.0	0.0	0.0	0.0	3.1
1945-46	0.0	0.0	0.0	0.0	0.0	2.0	2.9	3.4	0.0	0.0	0.0	0.0	8.3
1946-47	0.0	0.0	0.0	0.0	0.0	2.5	T	1.3	0.7	0.0	0.0	0.0	4.5
1947-48	0.0	0.0	0.0	0.0	0.0	0.5	4.8	T	T	0.0	0.0	0.0	5.3
1948-49	0.0	0.0	0.0	0.0	T	T	3.0	0.0	T	0.0	0.0	0.0	3.0
1949-50	0.0	0.0	0.0	0.0	0.0	T	2.3	T	T	0.0	0.0	0.0	2.3
1950-51	0.0	0.0	0.0	0.0	T	1.3	3.2	0.1	0.1	0.0	0.0	0.0	4.7
1951-52	0.0	0.0	0.0	0.0	0.4	T	0.0	0.6	0.0	0.0	0.0	0.0	1.0
1952-53	0.0	0.0	0.0	0.0	1.0	T	T	0.0	0.0	0.0	0.0	0.0	1.0
1953-54	0.0	0.0	0.0	0.0	0.0	T	4.0	0.0	0.0	0.0	0.0	0.0	4.0
1954-55	0.0	0.0	0.0	0.0	0.0	T	0.5	0.8	T	0.0	0.0	0.0	1.3
1955-56	0.0	0.0	0.0	0.0	0.0	T	3.8	T	T	0.0	0.0	0.0	2.8
1956-57	0.0	0.0	0.0	0.0	0.0	0.0	T	0.0	T	T	0.0	0.0	T
1957-58	0.0	0.0	0.0	0.0	0.8	T	T	4.2	T	0.0	0.0	0.0	5.0
1958-59	0.0	0.0	0.0	0.0	0.2	5.0	0.3	T	T	0.0	0.0	0.0	5.4
1959-60	0.0	0.0	0.0	0.0	0.0	T	11.6	9.6	5.4	0.0	0.0	0.0	26.6
1960-61	0.0	0.0	0.0	0.0	0.0	4.0	T	T	0.0	0.0	0.0	0.0	4.0
1961-62	0.0	0.0	0.0	0.0	T	T	4.0	T	T	0.0	0.0	0.0	4.0
1962-63	0.0	0.0	0.0	0.0	0.0	1.5	0.7	0.4	T	0.0	0.0	0.0	2.6
1963-64	0.0	0.0	0.0	0.0	0.0	4.8	T	0.0	T	0.0	0.0	0.0	4.8
1964-65	0.0	0.0	0.0	0.0	0.0	0.2	T	2.9	4.3	0.0	0.0	0.0	7.4
1965-66	0.0	0.0	0.0	0.0	0.0	0.0	12.0	9.4	0.0	0.0	0.0	0.0	21.4
1966-67	0.0	0.0	0.0	0.0	T	0.2	1.6	T	T	0.0	0.0	0.0	1.8
1967-68	0.0	0.0	0.0	0.0	T	1.1	1.0	4.3	T	0.0	0.0	0.0	6.4
1968-69	0.0	0.0	0.0	0.0	0.0	0.0	T	2.3	T	0.0	0.0	0.0	2.3
1969-70	0.0	0.0	0.0	0.0	T	T	4.0	T	T	0.0	0.0	0.0	4.0
1970-71	0.0	0.0	0.0	0.0	0.0	T	T	0.7	7.0	T	0.0	0.0	7.7
1971-72	0.0	0.0	0.0	0.0	4.0	0.6	0.1	0.3	0.0	0.0	0.0	0.0	5.0
1972-73	0.0	0.0	0.0	0.0	T	0.7	2.6	T	0.0	T	0.0	0.0	3.7
1973-74	0.0	0.0	0.0	0.0	0.0	T	0.3	T	0.0	0.0	0.0	0.0	0.3
1974-75	0.0	0.0	0.0	0.0	T	T	1.4	2.4	2.4	0.0	0.0	0.0	6.2
1975-76	0.0	0.0	0.0	0.0	0.2	1.0	T	0.0	0.0	0.0	0.0	0.0	1.2
1976-77	0.0	0.0	0.0	0.0	1.0	0.0	3.8	0.0	0.0	0.0	0.0	0.0	4.8
1977-78	0.0	0.0	0.0	0.0	0.0	0.0	10.0	3.4	T	0.0	0.0	0.0	13.4
1978-79	0.0	0.0	0.0	0.0	0.0	T	1.4	9.7	0.0	0.0	0.0	0.0	11.2
1979-80	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.5	T	T	0.0	0.0	1.4
1980-81	0.0	0.0	0.0	0.0	1.8	T	T	0.0	0.0	0.0	0.0	0.0	1.8
1981-82	0.0	0.0	0.0	0.0	0.0	0.0	5.0	6.4	T	0.0	0.0	0.0	11.4
1982-83	0.0	0.0	0.0	0.0	0.0	T	T	T	T	T	0.0	0.0	T
1983-84	0.0	0.0	0.0	0.0	0.0	2.8							
RECORD MEAN	0.0	0.0	0.0	0.0	0.2	0.8	2.3	1.3	0.5	T	0.0	0.0	5.2

LITTLE ROCK, ARKANSAS

Average Temperature

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1944	42.6	48.9	61.6	61.0	71.9	81.0	82.7	81.0	74.7	65.4	52.9	38.0	62.7
1945	38.8	47.9	59.6	63.9	67.3	76.7	79.3	80.0	74.9	61.4	53.4	38.0	61.5
1946	41.7	48.5	59.6	69.6	62.6	76.9	81.5	79.8	72.5	64.1	54.2	49.2	63.4
1947	43.9	38.1	46.7	62.4	68.8	77.8	79.3	80.0	76.0	69.7	48.2	45.2	61.7
1948	36.6	46.2	53.8	67.9	69.9	79.6	82.0	79.2	73.0	61.2	52.5	45.8	61.7
1949	40.9	47.6	52.0	62.0	71.2	79.5	83.2	79.0	70.2	65.0	56.1	43.5	62.6
1950	46.7	47.7	49.9	60.4	70.2	77.8	78.8	77.0	71.2	67.1	49.6	38.8	61.9
1951	40.2	44.6	52.5	59.2	71.0	77.8	81.9	82.8	72.8	63.9	46.0	46.0	61.8
1952	47.9	49.9	51.3	59.3	70.5	84.2	83.8	82.0	73.2	57.2	50.2	44.0	62.7
1953	46.9	46.6	57.1	62.0	73.8	85.0	81.9	81.5	77.1	66.3	51.0	42.3	63.9
1954	41.0	51.7	52.0	67.8	66.6	83.3	85.3	87.2	78.7	65.0	52.9	44.2	64.6
1955	42.5	46.6	54.1	67.6	73.2	74.7	83.8	81.4	77.3	63.6	50.4	42.5	62.9
1956	40.0	47.5	53.0	60.4	74.1	78.2	82.7	83.5	74.1	67.4	50.6	44.4	61.6
1957	39.8	50.4	51.1	62.4	72.4	78.8	82.7	80.2	72.4	60.3	52.2	48.1	62.1
1958	40.5	38.9	46.6	61.6	71.5	77.5	81.9	81.2	74.8	62.7	54.7	40.4	61.0
1959	39.7	45.1	53.1	62.2	74.0	77.4	79.6	81.4	75.2	64.1	47.0	44.6	62.2
*1960	41.3	39.9	41.3	64.9	68.4	79.4	80.7	81.4	76.3	63.5	50.7	37.6	60.4
1961	35.9	47.2	55.9	60.4	67.9	75.8	80.7	78.0	74.3	63.5	51.1	41.7	61.1
1962	37.3	49.2	53.5	59.5	75.3	77.7	81.9	82.0	73.2	66.3	50.7	41.8	62.1
1963	34.0	37.7	57.9	66.6	73.1	80.0	81.5	81.1	76.7	70.1	53.3	35.6	62.3
1964	40.8	41.6	52.7	64.3	73.0	79.5	82.2	82.5	74.4	60.3	55.4	43.5	62.3
1965	44.2	43.2	49.5	65.8	72.7	78.2	82.0	81.7	74.1	61.0	56.5	46.7	62.7
1966	35.4	42.9	56.6	62.9	68.4	79.0	84.2	77.4	72.0	59.2	59.8	43.2	61.1
1967	41.7	40.6	58.9	66.7	68.2	79.5	77.9	75.5	69.0	60.9	49.1	43.7	60.9
1968	37.7	38.0	50.0	60.4	67.6	77.0	77.0	81.4	70.7	62.4	51.2	42.2	59.9
1969	43.5	41.3	45.5	61.0	69.8	77.6	84.0	79.0	72.9	62.9	49.9	40.7	60.9
1970	35.7	42.1	48.7	63.1	73.9	79.3	81.9	81.2	78.7	61.5	50.3	47.2	61.5
1971	41.0	41.9	50.0	59.4	65.8	79.3	80.0	78.0	76.4	69.3	50.8	49.9	62.0
1972	43.6	46.7	55.3	62.5	69.8	79.4	80.4	81.1	75.8	62.4	47.3	41.0	62.0
1973	39.7	41.5	58.2	59.9	68.2	79.6	81.2	81.4	75.7	67.6	56.6	42.8	62.6
1974	42.4	45.7	58.1	60.7	71.3	79.3	83.2	79.0	69.0	63.9	51.9	44.4	61.9
1975	44.0	44.6	47.7	60.7	72.5	78.6	80.2	81.5	69.2	63.0	51.4	42.4	61.1
1976	39.1	51.5	56.5	61.1	66.6	78.4	80.2	79.7	72.1	57.0	45.9	41.9	60.8
1977	30.7	46.7	57.0	64.0	73.0	80.0	82.1	80.4	77.3	63.6	52.9	42.0	62.5
1978	31.7	34.0	46.0	64.9	71.9	80.0	84.4	81.0	78.3	62.5	52.4	45.3	61.0
1979	29.9	38.7	55.5	62.7	70.2	77.9	81.0	81.0	74.2	65.3	50.5	45.4	60.7
1980	44.0	40.9	50.3	61.3	70.6	79.4	88.1	87.0	78.6	60.0	50.4	43.1	62.4
1981	39.7	44.6	52.5	67.3	67.4	80.1	83.4	79.9	75.3	61.4	55.5	43.2	62.5
1982	37.5	41.3	57.1	59.0	72.7	76.6	83.1	82.1	74.2	64.7	53.2	48.3	62.4
1983	39.2	43.8	51.1	59.4	67.7	77.4	82.5	86.1	74.0	64.0	50.8	30.9	60.1
RECORD MEAN	41.4	44.6	53.0	62.4	70.2	78.2	81.5	80.6	74.2	63.7	51.9	43.7	62.1
MAX	50.0	55.4	62.7	72.4	79.9	87.8	91.0	90.4	84.4	74.4	61.6	52.3	71.7
MIN	32.7	35.4	43.2	52.4	60.4	68.5	71.9	70.8	64.0	52.4	42.7	35.1	51.5

Precipitation

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1944	2.06	8.90	7.06	4.71	5.02	3.54	3.35	2.82	1.07	0.01	6.08	0.33	48.03
1945	2.26	7.41	6.99	6.61	6.99	7.79	4.57	2.94	9.01	2.20	4.53	1.41	61.26
1946	8.22	3.09	8.22	4.81	9.67	3.39	2.56	0.69	0.83	2.56	2.88	3.23	55.15
1947	2.19	0.51	1.53	6.10	6.87	4.95	1.09	1.09	2.96	5.57	6.27	4.34	43.36
1948	1.56	7.14	6.43	4.59	4.56	2.25	3.41	3.11	1.20	3.11	8.00	2.70	48.21
1949	11.91	4.04	7.33	2.01	2.37	5.71	3.55	6.01	2.75	9.68	0.28	4.78	60.88
1950	12.53	9.27	4.90	2.75	8.37	2.07	1.87	7.59	6.77	1.29	3.40	1.55	67.86
1951	4.32	4.06	1.98	3.97	1.60	4.84	7.60	0.80	4.00	3.74	4.35	5.29	46.43
1952	3.49	5.02	5.61	4.06	4.69	T	3.05	2.50	2.55	0.54	6.84	5.39	43.58
1953	6.11	3.29	9.49	7.24	6.19	0.12	7.19	2.67	1.14	1.02	1.72	2.45	43.17
1954	7.76	3.00	2.14	4.13	6.74	0.63	1.27	0.33	1.78	3.64	1.45	4.15	37.42
1955	1.49	4.24	4.75	3.70	11.55	3.64	2.17	1.22	4.75	1.17	1.80	1.93	42.61
1956	5.77	11.02	3.81	4.68	3.21	5.08	5.47	2.25	0.28	3.04	5.12	2.65	52.34
1957	5.95	9.82	5.12	11.34	11.50	3.39	2.80	4.31	1.96	5.92	4.54	3.88	70.61
1958	4.41	3.93	4.20	8.21	7.84	7.20	3.37	3.80	7.16	0.31	5.35	1.26	55.27
1959	3.36	7.10	3.33	3.57	1.66	6.16	6.36	3.29	7.02	2.07	2.34	8.12	53.40
1960	4.21	4.37	3.67	1.05	5.74	7.25	2.34	2.11	6.21	2.96	1.77	4.09	45.44
1961	0.75	3.65	8.07	3.38	9.68	1.49	2.64	3.14	1.60	0.85	6.11	7.15	44.50
1962	6.84	7.19	5.17	2.90	2.31	6.26	3.10	2.90	3.43	3.54	1.69	1.65	46.88
1963	0.87	2.70	3.01	3.24	1.24	1.29	5.54	0.62	1.01	0.10	4.50	2.48	29.26
1964	0.98	3.87	8.22	11.06	1.80	0.31	3.74	3.71	5.46	0.37	3.70	4.37	46.24
1965	4.45	5.74	3.63	1.19	5.42	2.49	2.51	2.03	7.67	0.21	1.54	2.05	39.92
1966	3.03	5.02	0.73	7.24	2.21	0.69	3.54	14.96	1.42	1.95	3.08	4.21	47.65
1967	2.13	2.31	3.11	7.54	8.69	3.07	4.24	1.73	6.25	4.96	1.77	4.95	50.75
1968	4.76	1.08	5.55	4.05	12.74	6.17	5.94	0.26	5.49	2.81	5.30	4.56	60.65
1969	8.06	2.41	3.65	4.30	3.60	2.98	5.80	2.73	2.33	3.69	3.94	8.10	49.10
1970	1.05	4.57	4.87	7.94	0.69	2.30	3.82	2.15	2.82	7.64	2.04	3.55	43.08
1971	2.07	2.21	3.24	1.10	5.37	7.66	4.01	0.62	0.78	2.55	7.34	6.97	49.56
1972	1.71	1.55	3.32	1.61	2.07	2.62	1.77	3.58	6.43	7.61	7.18	5.14	45.01
1973	5.64	2.95	7.09	14.20	3.96	2.66	6.59	1.26	9.09	5.97	9.01	5.14	74.39
1974	5.77	2.60	2.07	9.76	6.26	7.87	4.09	3.20	4.31	3.36	5.73	2.99	57.96
1975	4.64	4.38	7.67	4.14	5.87	1.56	1.88	2.77	1.86	1.67	3.64	7.97	45.05
1976	3.00	5.12	5.43	1.08	4.08	5.64	1.97	0.70	1.92	6.04	1.14	2.30	37.40
1977	2.70	1.96	6.75	4.47	2.84	4.77	5.07	1.17	6.38	0.64	9.34	1.90	47.66
1978	5.44	1.52	3.56	4.22	6.17	5.34	2.70	6.34	10.17	1.01	6.69	11.56	64.86
1979	4.05	5.67	3.10	9.64	11.54	4.45	4.24	6.51	4.35	3.36	4.02	3.13	64.49
1980	2.13	0.89	6.60	5.85	4.57	0.53	0.44	0.17	5.09	2.64	6.24	1.46	39.22
1981	1.11	3.89	4.00	2.75	9.73	7.80	7.15	2.91	1.37	6.11	1.64	1.34	45.80
1982	9.74	3.37	2.87	4.12	5.63	4.10	1.01	8.52	1.47	2.26	9.71	8.28	61.29
1983	2.25	1.49	4.19	6.77	7.54	3.34	1.09	0.72	0.41	3.74	4.67	9.37	45.11
RECORD MEAN	4.47	3.86	4.64	5.14	5.05	3.71	3.34	3.31	3.35	2.51	4.21	4.22	45.39

FOOTNOTES

* Indicates a station move or relocation of instruments.

Record mean values above are means through the current year for the period beginning in 1880 for temperature and precipitation, 1953 for snowfall. Data are from City Office

SIOPB-PWN

5 March 1996

WP Production Schedule

	No. Shifts Per Month	Hrs Worked Per Shift	Hrs Worked Per Month
Feb 95	8	10	80
Mar 95	11	10	110
Apr 95	5	10	50
May 95	4	10	40
Jun 95	11	10	110
Jul 95	12	10	120
Aug 95	1	10	10
Sep 95	1	10	10
Oct 95	0	0	0
Nov 95	0	0	0
Dec 95	2	10	20
Jan 96	0	0	0
Feb 96	0	0	0
	55 [illegible]	TOTAL HRS WORKED:	550

NOTE: Each shift consists of 10 hrs, 0630 - 1700 hrs, four days/week.

Comfort Heating Calculations - Bin Temperature Method

Design IAT =	70	°F		
Belance Temp =	65	°F	(1)	From ASHRAE Handbook, 1981 Fundementels.
Design OAT (1) =	16	°F	(2)	From CDG Utility Study updated by PBA Production steff. Staam demend reduced by 30% for CDG's essumed lossas & by (Bel T-Des OAT)/(Des IAT - 0°), boiler eff = 70%.
Heeting Loed (2) =	89.2	MBtu/Hr	(3)	Bin tempereture dete from Engineering Waether Dete, TM 5-785.
			(4)	Percent Loed = (Balence Temp - OA Temp) / (Balenca Temp - Dasign OAT)
			(5)	MBtu = Heating Load x Parcent Loed x Hours

OA Temp	% Loed	Jan		Feb		Mar		Apr		Mey		Jun	
(3)	(4)	Hours (3)	MBtu (5)	Hours	MBtu	Hours	MBtu	Hours	MBtu	Hours	MBtu	Hours	MBtu
62	6%	36	197	32	175	77	421	127	694	95	519	24	131
57	16%	44	641	49	714	92	1340	105	1530	55	801	8	117
52	27%	54	1279	71	1681	103	2439	83	1965	29	687	1	24
47	37%	81	2655	96	3147	115	3770	43	1410	13	426		0
42	47%	103	4315	117	4901	112	4692	21	880	2	84		0
37	57%	108	5508	102	5202	75	3825	5	255		0		0
32	67%	122	7333	91	5469	44	2645	2	120		0		0
27	78%	84	5814	60	4153	17	1177		0		0		0
22	88%	48	3759	21	1645	5	392		0		0		0
17	98%	23	2011	7	612	1	87		0		0		0
12	100%	11	982	1	89	0	0		0		0		0
7	100%	5	446	0	0	0	0		0		0		0
2	100%	2	178	0	0	0	0		0		0		271
	Totels		35117		27788		20787		6854		2517		

OA Temp	% Load	Jul		Aug		Sep		Oct		Nov		Dec	
(3)	(4)	Hours (3)	MBtu (5)	Hours	MBtu	Hours	MBtu	Hours	MBtu	Hours	MBtu	Hours	MBtu
62	6%	8	44	17	93	63	344	123	672	86	470	44	240
57	16%	2	29	3	44	38	554	109	1588	102	1486	62	903
52	27%		0		0	12	284	90	2131	122	2889	77	1823
47	37%		0		0	3	98	55	1803	106	3475	107	3508
42	47%		0		0	1	42	26	1089	86	3603	129	5404
37	57%		0		0		0	8	408	61	3111	121	6171
32	67%		0		0		0	2	120	33	1983	85	5109
27	78%		0		0		0		0	13	900	57	3945
22	88%		0		0		0		0	4	313	24	1880
17	98%		0		0		0		0	1	87	13	1137
12	100%		0		0		0		0		0	3	268
7	100%		0		0		0		0		0	0	0
2	100%		0		0		0		0		0	0	0
													30387

calculations (WYEC) tape at 21 locations with 8760 hours of data for each station. The data are in the TRY format with solar data; 16 of the stations are solar reporting. Data for the other five are from the SOLMET publication of the National Climatic Center. The year is made up of monthly data from the U.S. Weather Service 1440 series tapes selected closest to the long term mean. Both temperature and solar radiation were examined for correlation and for closeness to the long term mean. Adjustments were made to secure close compliance to the long term mean by replacing days in the closest month with days from the same month in other years. At the connections (midnight), the temperatures were adjusted for fit. Erroneous data and atypical conditions were replaced with better data. This tape with accompanying text is available from ASHRAE Headquarters.

(*Continued on p. 24.22*)

TABLE 1 CLIMATIC CONDITIONS FOR THE UNITED STATES[a]

						Winter[d]		Summer[e]						
Col. 1	Col. 2		Col. 3		Col. 4	Col. 5		Col. 6			Col. 7	Col. 8		
State and Station	Latitude[b]		Longitude[b]		Elevation[c]	Design Dry-Bulb		Design Dry-Bulb and Mean Coincident Wet-Bulb			Mean Daily	Design Wet-Bulb		
	°	′	°	′	Ft	99%	97.5%	1%	2.5%	5%	Range	1%	2.5%	5%
ALABAMA														
Alexander City	33	0	86	0	660	18	22	96/77	93/76	91/76	21	79	78	78
Anniston AP	33	4	85	5	599	18	22	97/77	94/76	92/76	21	79	78	78
Auburn	32	4	85	3	730	18	22	96/77	93/76	91/76	21	79	78	78
Birmingham AP	33	3	86	5	610	17	21	96/74	94/75	92/74	21	78	77	76
Decatur	34	4	87	0	580	11	16	95/75	93/74	91/74	22	78	77	76
Dothan AP	31	2	85	2	321	23	27	94/76	92/76	91/76	20	80	79	78
Florence AP	34	5	87	4	528	17	21	97/74	94/74	92/74	22	78	77	76
Gadsden	34	0	86	0	570	16	20	96/75	94/75	92/74	22	78	77	76
Huntsville AP	34	4	86	4	619	11	16	95/75	93/74	91/74	23	78	77	76
Mobile AP	30	4	88	2	211	25	29	95/77	93/77	91/76	18	80	79	78
Mobile CO	30	4	88	1	119	25	29	95/77	93/77	91/76	16	80	79	78
Montgomery AP	32	2	86	2	195	22	25	96/76	95/76	93/76	21	79	79	78
Selma-Craig AFB	32	2	87	0	207	22	26	97/78	95/77	93/77	21	81	80	79
Talladega	33	3	86	1	565	18	22	97/77	94/76	92/76	21	79	78	78
Tuscaloosa AP	33	1	87	4	170r	20	23	98/75	96/76	94/76	22	79	78	77
ALASKA														
Anchorage AP	61	1	150	0	90	−23	−18	71/59	68/58	66/56	15	60	59	57
Barrow (S)	71	2	156	5	22	−45	−41	57/53	53/50	49/47	12	54	50	47
Fairbanks AP (S)	64	5	147	5	436	−51	−47	82/62	78/60	75/59	24	64	62	60
Juneau AP	58	2	134	4	17	−4	1	74/60	70/58	67/57	15	61	59	58
Kodiak	57	3	152	3	21	10	13	69/58	65/56	62/55	10	60	58	56
Nome AP	64	3	165	3	13	−31	−27	66/57	62/55	59/54	10	58	56	55
ARIZONA														
Douglas AP	31	3	109	3	4098	27	31	98/63	95/63	93/63	31	70	69	68
Flagstaff AP	35	1	111	4	6973	−2	4	84/55	82/55	80/54	31	61	60	59
Fort Huachuca AP (S)	31	3	110	2	4664	24	28	95/62	92/62	90/62	27	69	68	67
Kingman AP	35	2	114	0	3446	18	25	103/65	100/64	97/64	30	70	69	69
Nogales	31	2	111	0	3800	28	32	99/64	96/64	94/64	31	71	70	69
Phoenix AP(S)	33	3	112	0	1117	31	34	109/71	107/71	105/71	27	76	75	75
Prescott AP	34	4	112	3	5014	4	9	96/61	94/60	92/60	30	66	65	64
Tuscon AP (S)	32	1	111	0	2584	28	32	104/66	102/66	100/66	26	72	71	71
Winslow AP	35	0	110	4	4880	5	10	97/61	95/60	93/60	32	66	65	64
Yuma AP	32	4	114	4	199	36	39	111/72	109/72	107/71	27	79	78	77
ARKANSAS														
Blytheville AFB	36	0	90	0	264	10	15	96/78	94/77	91/76	21	81	80	78
Camden	33	4	92	5	116	18	23	98/76	96/76	94/76	21	80	79	78
El Dorado AP	33	1	92	5	252	18	23	98/76	96/76	94/76	21	80	79	78
Fayetteville AP	36	0	94	1	1253	7	12	97/72	94/73	92/73	23	77	76	75
Fort Smith AP	35	2	94	2	449	12	17	101/75	98/76	95/76	24	80	79	78
Hot Springs	34	3	93	1	535	17	23	101/77	97/77	94/77	22	80	79	78
Jonesboro	35	5	90	4	345	10	15	96/78	94/77	91/76	21	81	80	78
Little Rock AP (S)	34	4	92	1	257	15	20	99/76	96/77	94/77	22	80	79	78
Pine Bluff AP	34	1	92	0	204	16	22	100/78	97/77	95/78	22	81	80	80
Texarkana AP	33	3	94	0	361	18	23	98/76	96/77	93/76	21	80	79	78
CALIFORNIA														
Bakersfield AP	35	2	119	0	495	30	32	104/70	101/69	98/68	32	73	71	70
Barstow AP	34	5	116	5	2142	26	29	106/68	104/68	102/67	37	73	71	70
Blythe AP	33	4	114	3	390	30	33	112/71	110/71	108/70	28	75	75	74
Burbank AP	34	1	118	2	699	37	39	95/68	91/68	88/67	25	71	70	69
Chico	39	5	121	5	205	28	30	103/69	101/68	98/67	36	71	70	68

[a] Table 1 was prepared by ASHRAE Technical Committee 4.2, Weather Data, from data compiled from official weather stations where hourly weather observations are made by trained observers. See also Ref 1, 2, 3, 5 and 6.

[b] Latitude, for use in calculating solar loads, and longitude are given to the nearest 10minutes. For example, the latitude and longitude for Anniston, Alabama are given as 33 34 and 85 55 respectively, or 33° 40, and 85° 50.

[c] Elevations are ground elevations for each station. Temperature readings are generally made at an elevation of 5 ft above ground, except for locations marked r, indicating roof exposure of thermometer.

[d] Percentage of winter design data shows the percent of the 3-month period, December through February.

[e] Percentage of summer design data shows the percent of 4-month period, June through September.

4). Additional production lines could be constructed in the same facility or in existing nearby facilities.

5). Load, Assemble, and Pack (LAP) facilities can accommodate the desired production levels as specified by the three mobilization conditions.

6). Production rates are constant. It may be possible to increase production rates.

Monthly production capacity was compared to desired mobilization schedules for each chemical munitions/product per mobilization condition. If the monthly production capacity (summation of all production lines per munition) cannot meet or exceed the desired production (per mobilization condition), then additional production lines were assumed to be constructed and placed on line.

The following exhibit entitled "Required Monthly Production Capacity to Meet Mobilization Production Demands" lists all chemical munitions/products in the mobilization plan, and shows the effects of each production facility in terms of number of shifts and production lines required to fulfill each mobilization condition. (See Exhibit C)

C. STEAM DEMAND ANALYSIS:

The steam demand analysis consist of two portions: a) the building heat loads; and b) the process steam requirements per mobilization condition. Steam demand is calculated in pounds of steam per hour (lbs steam/hr).

1). Building Heat Loads: All of the steam and compressed air lines were visually inspected and video taped. In the course of video taping, all buildings with connections to the steam and compressed air lines were also video taped. This information was used to aid in compiling a basic inventory of the buildings within the production areas that require comfort heating. The area (footprint) of each building and the building construction composition was obtained from existing Pine Bluff Arsenal records. Ventilation requirements, if necessary, were obtained from Pine Bluff Arsenal engineering staff. Additional information concerning ventilation has been requested from Pine Bluff Arsenal engineering staff. All of this information was compiled in a spreadsheet format "data base". This data base was then sorted into similar building types. There are 51 distinct building types within all of the production areas in the scope of this study. See Exhibit D for a listing of all buildings within the study area that are served by steam and compressed air.

The steam plant buildings have been omitted from this listing because it was assumed that these buildings can easily be heated with "waste" heat from the plants.

Heating loads were calculated based on an outside temperature of 0° F and an inside temperature of 70° F. The inside temperature of 70° F is in accordance with Pine Bluff Arsenal design guidelines. The temperature of 0° F was selected in order to adequately model the possibility that a maximum mobilization condition could occur in the winter months. The Pine Bluff Arsenal engineers directed that all heating calculations be performed at 0°F. The industry standard (American Society for Heating, Refrigeration and Air Conditioning Engineers [ASHRAE]) for this area is 22°F. The following exhibits list all buildings requiring comfort heating (with the exclusion of steam plants), the associated heat loads in Btu's per hour (Btu/hr), and pounds of steam per hour (lbs steam/hr). An equipment effectiveness factor[3] of 30% has been included in the heating load stated in lbs. steam/hr. This heat load is used for all three mobilization conditions. See Exhibit E - Building Heat Loads.

The heating load is increased by approximately 46% for calculations based on 0° F rather than 22°F.

2). Process Steam Demands: Process steam demands were obtained and/or calculated for each production line (either existing or proposed). Process steam loads were then prepared per mobilization condition.

The following assumptions were made:

a). Steam demands were calculated based on the assumption that all chemical munitions/products are being produced simultaneously, at maximum levels.

b). Protective mask rebuild production occurs in Buildings 63-100 and 63-101. This product does not require any process steam.

The following exhibit illustrates the steam demands for each building for the three mobilization conditions by production area (see Exhibit F). Total steam demand per building was calculated by adding the building heat load (lbs steam/hr) to the process steam load (lbs steam/hr). It was assumed that there is no waste process heat available to heat the building.

D. COMPRESSED AIR ANALYSIS:

Compressed air demand was compiled primarily through interviews with Pine Bluff Arsenal engineering staff, and in some cases by calculation and engineering judgement. The following assumptions were made:

1). All chemical munitions/products are being produced simultaneously.

[3] *Equipment effectiveness factor represents the expected heat loss due to ineffectiveness of heating apparatus such as steam coils and line losses.*

EXHIBIT F
STEAM DEMAND FOR MOBILIZATION CONDITION

CDG UTILITY STUDY

EQUIPMENT EFFECTIVNESS FACTOR %

STEAM DEMANDS

PINE BLUFF ARSENAL, ARKANSAS
DEPARTMENT OF THE ARMY

BUILDING NUMBER	BLDG USE	VENILATION CFM	HEATIING LOAD LBS STEAM/HR	CURRENT DEMAND STEAM PROCESS LOAD LBS STEAM/HR	TOTAL LOAD LBS STEAM/HR	PARTIAL BASELINE EMERGENCY STEAM PROCESS LOAD LBS STEAM/HR	TOTAL LOAD LBS STEAM/HR	BASELINE EMERGENCY STEAM PROCESS LOAD LBS STEAM/HR	TOTAL LOAD LBS STEAM/HR
31080	ELECTRONIC CALIBRATION FACILITY		349.99		349.99		349.99		349.99
31100	MAINT FACILITY		1,730.12		1,730.12		1,730.12		1,730.12
31150	PRODUCTION OFFICE		248.92		248.92		248.92		248.92
31310	RAW MAT. WAREHOUSE		1,837.00		1,837.00		1,837.00		1,837.00
31330	RAW MAT. WAREHOUSE		1,837.00		1,837.00		1,837.00		1,837.00
31120	RAW MAT. WAREHOUSE		1,837.00		1,837.00		1,837.00		1,837.00
31440	RAW MAT. WAREHOUSE		1,837.00		1,837.00		1,837.00		1,837.00
31520	MIX BUILDING	15,290	2,005.00		2,005.00		2,005.00		2,005.00
31530	FILL AND PRESS	29,010	3,728.00	750 750	4,478.00	1500	5,228.00	1500	5,228.00
31531	OFFICE AND RESTROOMS		239.26		239.26		239.26		239.26
31540	DOWNLOAD FACILITY		947.03		947.03		947.03		947.03
31570	MUNITIONS STORAGE		1,187.97		1,187.97		1,187.97		1,187.97
31620 L	PYRO MIX BLDG (THERMATE MIX)	14,860	0 1,949.00	0 20	1,969.00	20	1,969.00	20	1,969.00
31630 L	FILL AND PRESS	10,000	0 2,852.19	0 300	3,152.19	0	2,852.19	500	3,352.19
31631	BREAK AND RESTROOMS		239.26		239.26		239.26		239.26
31640	ASSEMBLY		947.03		947.03		947.03		947.03
31670	STORAGE		1,187.97		1,187.97		1,187.97		1,187.97
31720 L	PYROTECHNIC PRODUCTION	2,870	0 454.00	0 100	554.00	100	554.00	100	554.00
31730	STORAGE		149.86		149.86		149.86		149.86
31820	STORAGE		301.43		301.43		301.43		301.43
31830	AMMO QUAL FAC		149.86		149.86		149.86		149.86
31860	STORAGE		159.50		159.50		159.50		159.50
			20919 26,174.42	750 1,170.00	27,344.42	1,620.00	27,794.42	2,120.00	28,294.42
32000	CAFETERIA		512.16		512.16		512.16		512.16
32030	INSPECTION GARAGE		706.04		706.04		706.04		706.04
32035	ORDINANCE SHOP		0.00		0.00		0.00		0.00
32070	IMPREG AND LAUNDRY		1,909.25	93	2,002.25	93	2,002.25	93	2,002.25
32080	MHE BATTERY SHOP		349.99		349.99		349.99		349.99
32090	WAREHOUSE		855.31		855.31		855.31		855.31
32100	ELECTRONIC CALIBRATION FACILITY		1,730.12		1,730.12		1,730.12		1,730.12
32130	AMMO QUAL FAC		561.96		561.96		561.96		561.96
32150	AMMO QUAL FAC		248.92		248.92		248.92		248.92
32230	FILTER BLDG		1,628.91		1,628.91		1,628.91		1,628.91
32270	WAREHOUSE		1,628.91	0	1,628.91	0	1,628.91	0	1,628.91
32310	RAW MAT. WAREHOUSE		1,837.00		1,837.00		1,837.00		1,837.00
32330	RAW MAT. WAREHOUSE		1,837.00		1,837.00		1,837.00		1,837.00
32420	RAW MAT. WAREHOUSE		1,837.00		1,837.00		1,837.00		1,837.00
32440	EQUIPEMENT WAREHOUSE		1,837.00		1,837.00		1,837.00		1,837.00
32510	PROD ENGR LAB		518.13		518.13		518.13		518.13
32520	PROD ENGR LAB		1,067.96		1,067.96		1,067.96		1,067.96
32530	FORMER BZ FACILITY		2,543.52		2,543.52		2,543.52		2,543.52
32531			151.46		151.46		151.46		151.46

A.4-17

CDG UTILITY STUDY

EXHIBIT F
STEAM DEMAND FOR MOBILIZATION CONDITION

EQUIPMENT EFFECTIVNESS FACTOR %

STEAM DEMANDS

PINE BLUFF ARSENAL, ARKANSAS
DEPARTMENT OF THE ARMY

BUILDING NUMBER	BLDG USE	VENILATION CFM	HEATIING LOAD LBS STEAM/HR	CURRENT DEMAND STEAM PROCESS LOAD LBS STEAM/HR	TOTAL LOAD LBS STEAM/HR	PARTIAL BASELINE EMERGENCY STEAM PROCESS LOAD LBS STEAM/HR	TOTAL LOAD LBS STEAM/HR	BASELINE EMERGENCY STEAM PROCESS LOAD LBS STEAM/HR	TOTAL LOAD LBS STEAM/HR
32540	FORMER BZ FACILITY		947.03		947.03		947.03		947.03
32550	AMMO QUAL FAC		353.92		353.92		353.92		353.92
32570	OPERATIONS GENERAL PURPOSE		1,209.30		1,209.30		1,209.30		1,209.30
32610	DRYING	14,900	1,705.00	7.26	1,712.26	7.26	1,712.26	7.26	1,712.26
32620	COLORED SMOKE MIX (GLATT)	15,290	2,005.00	100% OA 436	2,441.00	872	2,877.00	672	2,877.00
32630	STORAGE		1,673.76		1,673.78		1,673.78		1,673.76
32631	OFFICE AND RESTROOMS		239.26		239.26		239.26		239.26
32640	PYROTECHNIC PRODUCTION	12,510	2,206.10	100	2,206.10		2,206.10		2,206.10
32670	SUU-7 TEST		1,187.97		1,187.97		1,187.97		1,187.97
32720	PROD ENGR LAB		416.58		418.58		418.58		418.58
32730	PROD ENGR LAB		173.74		173.74		173.74		173.74
32820	MATERIAL STORAGE		301.43		301.43		301.43		301.43
32830	MATERIAL STORAGE		149.86		149.86		149.86		149.86
32860	STORAGE		159.50		159.50		159.50		159.50
			34,491.10	636 536.26	35,027.36	972.26	35,463.36	972.26	35,463.36
33080	SAFETY EQUIP		349.99		349.99		349.99		349.99
33100	CHANGE HOUSE		1,730.12		1,730.12		1,730.12		1,730.12
33150	PRODUCTION		248.92		248.92		248.92		248.92
33310	RAW MAT. WAREHOUSE		1,837.00		1,837.00		1,837.00		1,837.00
33330	RAW MAT. WAREHOUSE		1,837.00		1,837.00		1,637.00		1,837.00
33420	RAW MAT. WAREHOUSE		1,837.00		1,837.00		1,837.00		1,837.00
33440	RAW MAT. WAREHOUSE		1,837.00		1,837.00		1,837.00		1,837.00
33520	MIX BUILDING	16,610	1,944.00		1,944.00		1,944.00		1,944.00
33530	FILL AND PRESS	26,900	4,675.86	50	4,725.86	50	4,725.86	50	4,725.86
33531	PUBLIC TOILET		239.26		239.26		239.26		239.26
33540	STORAGE		948.37		948.37		948.37		948.37
33550	IN PROCESS STORAGE		388.02		388.02		388.02		388.02
33570	LAP		1,187.97	0	1,187.97	0	1,187.97	0	1,187.97
33820	STARTER MIX BUILDING		1,067.96	100	1,167.96	100	1,167.96	100	1,167.96
33630 (1)	FILL AND PRESS	10,000	0 2,420.61	0	2,420.61	300	2,720.61	300	2,720.61
33631	OFFICE AND RESTROOMS		239.26		239.26		239.26		239.26
33640	ASSEMBLY BUILDING		947.03		947.03		947.03		947.03
33650	IN PROCESS STORAGE		353.92		353.92		353.92		353.92
33670	M116 LAP		1,187.97		1,187.97		1,187.97		1,167.97
33720	KC103 PROP		301.43		301.43		301.43		301.43
33730	OC TEST FAC		149.86		149.88		149.88		149.86
33820	STARTER MIX SLUGS		301.43		301.43		301.43		301.43
33830	COMPONENT STORAGE		149.86		149.86		149.86		149.86
33860	STORAGE IGLOO		159.50		159.50		159.50		159.50
			23919 26,339.36	150 150.00	28,489.36	450.00	28,789.36	450.00	26,789.36

A.4-18

EXHIBIT F
STEAM DEMAND FOR MOBILIZATION CONDITION

CGD UTILITY STUDY

QUIPMENT EFFECTIVNESS FACTOR %

STEAM DEMANDS

'INE BLUFF ARSENAL, ARKANSAS
)EPARTMENT OF THE ARMY

UILDING IUMBER	BLDG USE	VENILATION CFM	HEATIING LOAD LBS STEAM/HR	CURRENT DEMAND STEAM PROCESS LOAD LBS STEAM/HR	TOTAL LOAD LBS STEAM/HR	PARTIAL BASELINE EMERGENCY STEAM PROCESS LOAD LBS STEAM/HR	TOTAL LOAD LBS STEAM/HR	BASELINE EMERGENCY STEAM PROCESS LOAD LBS STEAM/HR	TOTAL LOAD LBS STEAM/HR
4110	WP FILLING	139,310	16,957.00	10602.42	27,559.42	14136.56	31,093.58	14136.56	31,093.56
4120	AMMO QUAL FAC		1,221.45		1,221.45		1,221.45		1,221.45
4130	WP UNLOAD TANKS		474.95	7555.06	8,030.01	7555.06	8,030.01	7555.06	8,030.01
4170	WP BULK STORAGE			21859 27	21,659.27	21659.27	21,659.27	21659.27	21,659.27
4350	ASSEMBLY AND PACKOUT		879.89		879.89		879.89		879.89
4370			331.19		331.19		331.19		331.19
4420			319.82		319.82		319.82		319.82
4430	RAW MATERIAL WAREHOUSE		1,861.28		1,861.28		1,861.28		1,861.28
4620			1,768.37		1,768.37		1,768.37		1,768.37
4630	PYROTECHNIC PRODUCTION	8,000	2,270.12	1200	3,470.12	1200	3,470.12	1200	3,470.12
4640	HC MIX	57,820	5,761.00	1200	5,761.00		5,761.00		5,761.00
4650	START MIX SLEEVE		1,369.83	100	1,369.83		1,369.83		1,369.83
4660	SUB ASSEMBLY		328.47		326.47		328.47		326.47
4820	STORAGE		159.50		159.50		159.50		159.50
34910	FE MAINTENANCE SHOP		9,832.65		9,632.65		9,632.65		9,632.65
4970	ADMIN BUILDING		451.97		451.97		451.97		451.97
			43,785.48	42317 41,016.75	84,802.23	44,550.89	88,336.37	44,550.89	88,336.37
42960	GRENADE TEST BUILDING		421.00		421.00		421.00		421.00
44110	LAP		3,957.49	33	3,990.49	33	3,990.49	33	3,990.49
			135,168.85	42,906.01	178,074.86	47,628.15	182,795.00	48,128.15	183,295.00
			127493	43886					

A.4-19

06/26/95

LITTLE ROCK AFB ARKANSAS

LAT 34 55N LONG 92 09W ELEV 311 FT

MEAN FREQUENCY OF OCCURRENCE OF DRY BULB TEMPERATURE (DEGREES F) WITH MEAN COINCIDENT WET BULB TEMPERATURE (DEGREES F) FOR EACH DRY BULB TEMPERATURE RANGE

Temperature Range	MAY Obsn Hour Gp 01 to 08	MAY 09 to 16	MAY 17 to 24	MAY Total Obsn	MAY MCWB	JUNE Obsn Hour Gp 01 to 08	JUNE 09 to 16	JUNE 17 to 24	JUNE Total Obsn	JUNE MCWB
105/109										
100/104							0		0	77
95/99		0		0	75		7	1	8	76
90/94		9	1	10	71		42	13	55	75
85/89		31	12	43	70	1	68	36	105	74
80/84	1	59	33	93	69	12	59	58	129	72
75/79	12	53	50	115	67	57	39	60	156	70
70/74	45	39	55	139	65	89	20	50	159	68
65/69	71	32	47	150	62	53	5	16	74	64
60/64	51	16	28	95	58	19	1	4	24	59
55/59	34	7	14	55	53	7		1	8	55
50/54	20	2	7	29	49	1		0	1	50
45/49	12	0	1	13	45	0			0	47
40/44	2			2	41					
35/39										
30/34										
25/29										

Temperature Range	JULY Obsn Hour Gp 01 to 08	JULY 09 to 16	JULY 17 to 24	JULY Total Obsn	JULY MCWB	AUGUST Obsn Hour Gp 01 to 08	AUGUST 09 to 16	AUGUST 17 to 24	AUGUST Total Obsn	AUGUST MCWB
105/109							0		0	79
100/104		3	0	3	78		2	0	2	77
95/99		25	6	31	78		13	3	16	77
90/94	0	62	24	86	77		55	17	72	76
85/89	3	74	46	123	75	1	74	38	113	74
80/84	30	48	64	142	74	18	55	63	136	73
75/79	99	26	69	194	72	77	36	71	184	72
70/74	84	9	31	124	69	91	10	41	142	69
65/69	22	1	6	29	64	44	3	13	60	64
60/64	7		1	8	59	15	0	2	17	60
55/59	2			2	56	3		0	3	56
50/54										
45/49										
40/44										
35/39										
30/34										
25/29										

Temperature Range	SEPTEMBER Obsn Hour Gp 01 to 08	SEPTEMBER 09 to 16	SEPTEMBER 17 to 24	SEPTEMBER Total Obsn	SEPTEMBER MCWB	OCTOBER Obsn Hour Gp 01 to 08	OCTOBER 09 to 16	OCTOBER 17 to 24	OCTOBER Total Obsn	OCTOBER MCWB
105/109										
100/104										
95/99		3	0	3	75					
90/94		22	4	26	76		2	0	2	66
85/89		45	15	60	73		12	2	14	70
80/84	2	53	34	89	71		31	8	39	67
75/79	28	52	56	136	70	1	39	22	62	65
70/74	72	36	59	167	68	11	44	35	90	63
65/69	60	19	39	118	63	32	44	47	123	60
60/64	37	6	20	63	58	42	37	44	123	56
55/59	27	2	9	38	54	44	25	40	109	52
50/54	10	0	2	12	50	48	11	31	90	48
45/49	2		1	3	45	39	3	13	55	43
40/44	1		0	1	40	21	0	5	26	39
35/39						7		1	8	36
30/34						2		0	2	31
25/29						0			0	28

LITTLE ROCK AFB ARKANSAS

Temperature Range	NOVEMBER Obsn Hour Gp 01 to 08	NOVEMBER Obsn Hour Gp 09 to 16	NOVEMBER Obsn Hour Gp 17 to 24	NOVEMBER Total Obsn	NOVEMBER MCWB	DECEMBER Obsn Hour Gp 01 to 08	DECEMBER Obsn Hour Gp 09 to 16	DECEMBER Obsn Hour Gp 17 to 24	DECEMBER Total Obsn	DECEMBER MCWB	JANUARY Obsn Hour Gp 01 to 08	JANUARY Obsn Hour Gp 09 to 16	JANUARY Obsn Hour Gp 17 to 24	JANUARY Total Obsn	JANUARY MCWB
105/109															
100/104															
95/99															
90/94															
85/89															
80/84		2	0	2	68							0		0	63
75/79		8	1	9	64		0	0	0	66		1	0	1	64
70/74	2	22	8	32	62	1	4	1	6	63		4	1	5	62
65/69	8	32	21	61	59	2	11	5	18	60	2	9	6	17	60
60/64	16	38	32	86	55	8	21	15	44	56	9	14	13	36	57
55/59	27	36	39	102	51	14	26	22	62	52	10	20	14	44	51
50/54	39	40	43	122	47	15	36	26	77	46	8	27	19	54	46
45/49	39	30	37	106	42	26	41	40	107	42	15	33	33	81	42
40/44	40	16	30	86	38	39	41	49	129	38	31	36	36	103	38
35/39	35	9	17	61	34	47	32	42	121	34	35	34	39	108	33
30/34	21	5	7	33	29	41	19	25	85	29	48	32	42	122	29
25/29	9	1	3	13	25	30	11	16	57	25	42	20	22	84	25
20/24	3	0	1	4	20	15	4	5	24	20	25	10	13	48	20
15/19	1			1	16	8	2	3	13	16	12	5	6	23	15
10/14						2	0	1	3	11	6	3	2	11	11
5/9						0	0	0	0	6	3	1	1	5	7
0/4						0			0	4	2	0	0	2	2
-5/-1											0			0	-2

Temperature Range	FEBRUARY Obsn Hour Gp 01 to 08	FEBRUARY Obsn Hour Gp 09 to 16	FEBRUARY Obsn Hour Gp 17 to 24	FEBRUARY Total Obsn	FEBRUARY MCWB	MARCH Obsn Hour Gp 01 to 08	MARCH Obsn Hour Gp 09 to 16	MARCH Obsn Hour Gp 17 to 24	MARCH Total Obsn	MARCH MCWB	APRIL Obsn Hour Gp 01 to 08	APRIL Obsn Hour Gp 09 to 16	APRIL Obsn Hour Gp 17 to 24	APRIL Total Obsn	APRIL MCWB
105/109															
100/104															
95/99															
90/94												1	0	1	68
85/89							2	1	3	67		6	2	8	67
80/84		0		0	63		5	2	7	64		25	11	36	66
75/79		1	1	2	62		9	6	15	63	2	36	25	63	65
70/74	0	5	2	7	59	2	16	12	30	59	18	44	39	101	62
65/69	0	9	6	15	56	8	24	18	50	57	35	46	45	126	59
60/64	5	16	11	32	54	15	32	30	77	54	47	38	42	127	56
55/59	8	22	19	49	50	23	35	34	92	50	42	25	38	105	51
50/54	17	31	23	71	46	27	39	37	103	45	44	14	25	83	47
45/49	22	36	38	96	42	37	35	43	115	42	29	5	9	43	43
40/44	36	38	43	117	38	54	25	33	112	38	17	1	3	21	38
35/39	38	29	35	102	33	41	15	19	75	33	5	0	0	5	34
30/34	42	20	29	91	29	25	8	11	44	29	1	0	1	2	31
25/29	35	12	13	60	25	12	2	3	17	25					
20/24	14	3	4	21	20	3	1	1	5	20					
15/19	5	1	1	7	16	1	0		1	16					
10/14	1			1	12										
5/9															
0/4															
-5/-1															

Temperature Range	ANNUAL TOTAL Obsn Hour Gp 01 to 08	ANNUAL TOTAL Obsn Hour Gp 09 to 16	ANNUAL TOTAL Obsn Hour Gp 17 to 24	ANNUAL TOTAL Total Obsn	ANNUAL TOTAL MCWB
105/109		0		0	79
100/104		5	0	5	77
95/99		48	10	58	77
90/94	0	193	59	252	76
85/89	5	312	152	469	74
80/84	63	337	273	673	71
75/79	276	300	361	937	70
70/74	415	253	334	1002	66
65/69	337	235	269	841	61
60/64	271	219	242	732	56
55/59	241	198	230	669	51
50/54	229	200	213	642	47
45/49	221	183	215	619	42
40/44	241	157	199	597	38
35/39	208	119	153	480	33
30/34	180	84	115	379	29
25/29	128	46	57	231	25
20/24	60	18	24	102	20
15/19	27	8	10	45	15
10/14	9	3	3	15	11
5/9	3	1	1	5	7
0/4	2	0	0	2	2
-5/-1	0			0	-2

A.4-21

Conduction Loss Calculations

Pipe Temperature = 350.1 °F (for 120 psig, see attached steam tables)

Insultion Thickness = 2.5 inches

Nominal Pipe Dia.	Pipe IR r_a (ft)	Steam h_a (1)	Pipe OR r_b (ft)	Still Air h_b (1)	Ins. OR r_c (ft)	Out. Air h_c (1)	k pipe (1) B•ft/h•sf°F	k ins (1) B•ft/h•sf°F	Pipe Lnth Ft (2)	Steam (3) Btu/hr°F	N. Gas (4) MBtu/hr°F
1"	0.0874	2000	0.0985	1.65	0.307	6.00	27	0.03	5280	744	0.0011
2"	0.172	2000	0.185	1.65	0.393	6.00	27	0.03	3960	863	0.0012
3"	0.256	2000	0.274	1.65	0.482	6.00	27	0.03	3960	1161	0.0017
4"	0.336	2000	0.355	1.65	0.564	6.00	27	0.03	3960	1431	0.0020
5"	0.421	2000	0.442	1.65	0.650	6.00	27	0.03	3960	1716	0.0025
6"	0.505	2000	0.529	1.65	0.737	6.00	27	0.03	15840	7995	0.0114
										Total	0.0199

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
OAT (5)	41.4	44.6	53	62.4	70.2	78.2	81.5	80.6	74.2	63.7	51.9	43.7
Hrs/Mo	744	672	744	720	744	720	744	744	720	744	720	744
MB/Mo (6)	4564	4080	4392	4116	4138	3890	3971	3984	3947	4234	4266	4530

(1) From the Mechanical Engineering Review Manual, Table 3.2 and Table 3.3, see attached pages.
(2) Pipe length estimated from General Heating Maps for PBA, pages 73 and 74.
(3) From the Mechanical Engineering Review Manual, Equation 3.15, page 3-6, see attached.
(4) N. Gas MBtu/hr°F = (Steam Btu/hr°F / boiler eff.) x (1MBtu / 1000000Btu), assumes boiler eff. = 70%.
(5) Average outside air temperatures from The Weather Almanac, Fourth Edition, 30 year average monthly temperatures.
(6) Conduction Losses MBtu/Mo = N. Gas MBtu/hr°F x (Pipe Temp - OAT) x Hrs/Mo.

PROPERTIES OF SATURATED STEAM

Gauge Pressure psig	Absolute Pressure psia	Temperature °F	Heat Content: Sensible (hf) BTU/lb	Heat Content: Latent (h_{fg}) BTU/lb	Heat Content: Total (h_g) BTU/lb	Specific Volume Steam (V_g) ft³/lb
52	66.7	299.7	269.4	910.7	1,180.1	6.50
54	68.7	310.7	271.5	909.2	1,180.7	6.32
56	70.7	303.6	273.5	907.8	1,181.3	6.16
58	72.7	305.5	275.3	906.5	1,181.8	6.00
60	74.7	307.4	277.1	905.3	1,182.4	5.84
62	76.7	309.2	279.0	904.0	1,183.0	5.70
64	78.7	310.9	280.9	902.6	1,183.5	5.56
66	80.7	312.7	282.8	901.2	1,184.0	5.43
68	82.7	314.3	284.5	900.0	1,184.5	5.31
70	84.7	316.0	286.2	898.8	1,185.0	5.19
72	86.7	317.7	288.0	897.5	1,185.5	5.08
74	88.7	319.3	289.4	896.5	1,185.9	4.97
76	90.7	320.9	291.2	895.1	1,186.3	4.87
78	92.7	322.4	292.9	893.9	1,186.8	4.77
80	94.7	323.9	294.5	892.7	1,187.2	4.67
82	96.7	325.5	296.1	891.5	1,187.6	4.58
84	98.7	326.9	297.6	890.3	1,187.9	4.49
86	100.7	328.4	299.1	889.2	1,188.3	4.41
88	102.7	329.9	300.6	888.1	1,188.7	4.33
90	104.7	331.2	302.1	887.0	1,189.1	4.25
92	106.7	332.6	303.5	885.8	1,189.3	4.17
94	108.7	333.9	304.9	884.8	1,189.7	4.10
96	110.7	335.3	306.3	883.7	1,190.0	4.03
98	112.7	336.6	307.7	882.6	1,190.3	3.96
100	114.7	337.9	309.0	881.6	1,190.6	3.90
102	116.7	339.2	310.3	880.6	1,190.9	3.83
104	118.7	340.5	311.6	879.6	1,191.2	3.77
106	120.7	341.7	313.0	878.5	1,191.5	3.71
108	122.7	343.0	314.3	877.5	1,191.8	3.65
110	124.7	344.2	315.5	876.5	1,192.0	3.60
112	126.7	345.4	316.8	875.5	1,192.3	3.54
114	128.7	346.5	318.0	874.5	1,192.5	3.49
116	130.7	347.7	319.3	873.5	1,192.8	3.44
118	132.7	348.9	320.5	872.5	1,193.0	3.39
120	134.7	350.1	321.8	871.5	1,193.3	3.34
125	139.7	352.8	324.7	869.3	1,194.0	3.23
130	144.7	355.6	327.6	866.9	1,194.5	3.12
135	149.7	358.3	330.6	864.5	1,195.1	3.02
140	154.7	360.9	333.2	862.5	1,195.7	2.93
145	159.7	363.5	335.9	860.3	1,196.2	2.84
150	164.7	365.9	338.6	858.0	1,196.6	2.76
155	169.7	368.3	341.1	856.0	1,197.1	2.68
160	174.7	370.7	343.6	853.9	1,197.5	2.61
165	179.7	372.9	346.1	851.8	1,197.9	2.54
170	184.7	375.2	348.5	849.8	1,198.3	2.48
175	189.7	377.5	350.9	847.9	1,198.8	2.41
180	194.7	379.6	353.2	845.9	1,199.1	2.35
185	199.7	381.6	355.4	844.1	1,199.5	2.30
190	204.7	383.7	357.6	842.2	1,199.8	2.24
195	209.7	385.7	359.9	840.2	1,200.1	2.18
200	214.7	387.7	362.0	838.4	1,200.4	2.14
210	224.7	391.7	366.2	834.8	1,201.0	2.04
220	234.7	395.5	370.3	831.2	1,201.5	1.96

At common temperatures, conductivity in solids varies according to

$$k(T) = k_o(1 + \gamma T) \tag{3.3}$$

γ is positive for amorphous materials and insulators (e.g., brick, graphite, etc.) and negative for crystalline materials (with the exceptions of aluminum and brass). Tabulated values of γ are not common, having been replaced with tabulations of k itself versus T for various common materials. In most calculations, the average thermal conductivity (conductivity at the arithmetic mean temperature) is used, and no other attention is paid to variations in conductivity with temperature.

In liquids, heat is transmitted by longitudinal vibrations, similar to sound waves. According to Bridgeman (1921),

$$k = \frac{3k^*a}{d^2} \tag{3.4}$$

Conductivity in water and aqueous solutions increases with increases in temperature up to around 250°F, and then gradually decreases. Conductivity decreases with increased concentrations of aqueous solutions, as it does with most other liquids. Conductivity increases with increases in pressure. Of the non-metallic liquids, water is the best thermal conductor.

The net transport theory can be used to explain heat conduction through gases. Hot molecules move faster than cold molecules, traveling to cold areas with greater frequency than cold molecules travel to hot areas. It can be shown that

$$k = \frac{N\bar{v}fk^*\lambda}{6} \tag{3.5}$$

Conductivity in gases increases almost linearly with increases in temperature, but is fairly independent of pressure in common ranges.

The table below gives the thermal conductivities for some of the more common materials. The back of this chapter has a more extensive list. Notice that BTU-ft/hr-ft²-°R is the same as BTU/hr-°R-ft. However, these are not the same as BTU-in/hr-°R-ft² which is also widely used. Multiply cal-cm/sec-°K-cm² by 241.9 to get ft-English units.

Table 3.2

Typical Thermal Conductivities, BTU-ft/hr-ft²-°R

Material	k	Material	k	Material	k
Silver	242	Lead	20.	Hydrogen	.11
Copper	224	Ice	1.3	Fiberglass	.03
Aluminum	117	Concrete	.5	Cork	.025
Brass	56	Glass	.63	Air	.014
Steel 1%C	27	Water	.32	Oxygen	.016

All of the above conductivities were evaluated at 32°F except hydrogen which was evaluated at 100°F.

2. Conduction

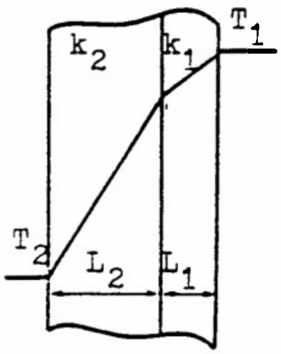
Conduction, the flow of heat through solids, is given by Fourier's law:

$$q = kA\left(\frac{dT}{dL}\right) \qquad 3.6$$

If the heat transmission is steady and both k and A are constant, heat flow through a single slab of thickness L is given by equation 3.7:

Figure 3.1

$$q = kA\Delta T/L \qquad 3.7$$



The heat flow due to conduction for composite sandwiched materials, as shown in Figure 3.1, is:

$$q = \frac{A\Delta T}{\Sigma\left(\frac{L_i}{k_i}\right)} \qquad 3.8$$

To further complicate the problem, there is usually a film on the exposed surfaces. There may also be a film between layers, although perfect bonding is usually assumed.

To account for films on exposed surfaces without having to measure the film thickness, the film thermal resistance is given by a film coefficient, h. The heat flow through a film is

$$q = hA\Delta T \qquad 3.9$$

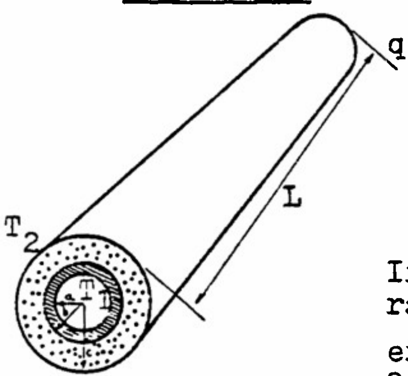
Table 3.3 (5:69)

Film Coefficients in BTU/hr-ft^2-°F

No change in state	
air, still	1.65
air, with 15 mph wind	6.00
water	150 to 2000
other gases	3 to 50
gasoline, kerosene, alcohol and other organic solvents	60 to 500
oils	10 to 120
Condensing	
steam	1000 to 3000
organic solvents	150 to 500
light oils	200 to 400
heavy oils	20 to 50
ammonia	500 to 1000
Evaporating	
water	800 to 2000
organic solvents	100 to 300
light oils	150 to 300
heavy oils	10 to 50
ammonia	200 to 400
R-12	100 to 600

The commonly encountered insulated pipe with films can be solved by using equation 3.15, which requires all dimensions to be in feet.

Figure 3.2



$$q = \frac{2\pi L \Delta T}{\frac{1}{r_a h_a} + \frac{\ln\left(\frac{r_b}{r_a}\right)}{k_{pipe}} + \frac{1}{r_b h_b} + \frac{\ln\left(\frac{r_c}{r_b}\right)}{k_{insul.}} + \frac{1}{r_c h_c}} \qquad 3.15$$

If the wall and layers are very thin, or if the radii are large so that $A = A_a = A_c$, then the effects of curvature can be ignored and equation 3.10 can be used.

Example 3.2

Liquid oxygen at -290°F is stored in a 5' inside diameter, 20' long cylindrical stainless steel tank covered with 1 foot of powdered diatomaceous silica with average thermal conductivity of .022 BTU/ft-hr-°F. The environment temperature is 70°F and the wind is 15 mph. The tank walls are 3/8" thick. Compare the heat gain to the liquid oxygen using equations 3.15 and 3.10.

Required data:

material	t	k	h
stainless	.031	28.0	
silica	1.0	.022	
air, outside			6.0
oxygen, inside			∞

Equation 3.15 gives the exact solution as

$$q = \frac{2\pi(20)(70+290)}{\frac{\ln\left(\frac{2.53}{2.50}\right)}{28.0} + \frac{\ln\left(\frac{3.53}{2.53}\right)}{.022} + \frac{1}{(3.53)(6.0)}} = 2980 \text{ BTU/hr}$$

If the effects of curvature are ignored, equation 3.10 predicts the heat loss based on the outside area to be:

$$q = \frac{2\pi(3.53)(20)(70+290)}{\frac{.031}{28.0} + \frac{1.0}{.022} + \frac{1}{6}} = 3500 \text{ BTU/hr}$$

Since the addition of a covering (insulation) to a bare pipe also increases the surface area, adding insulation up to the critical thickness will actually increase the heat loss above bare-pipe levels. This critical radius is usually very small, and is most relevant in the cases of thin wires or capillaries. The critical radius is given by:

$$r_{critical} = \frac{k_{insulation}}{h} \qquad 3.16$$

LITTLE ROCK, ARKANSAS

Normals, Means, And Extremes

A.4-27

Month	Normal Degree days Base 65 °F Heating	Cooling	Precipitation in inches Water equivalent Normal
(a)			
JAN	776	0	3.91
FEB	583	0	3.83
MAR	417	20	4.69
APR	124	48	5.41
MAY	18	188	5.29
JUN	0	405	3.67
JUL	0	530	3.63
AUG	0	468	3.07
SEP	8	287	4.26
OCT	132	73	2.84
NOV	419	0	4.17
DEC	676	0	4.21
YEAR	3152	2045	49.20

FOOTNOTES

Means and extremes above are from existing and comparable exposures. Annual extremes have been exceeded at other sites in the locality as follows: Highest temperature 110 in August 1936; lowest temperature -13 in February 1899; maximum monthly precipitation 15.04 in January 1937; maximum precipitation in 24 hours 5.58 in April 1911; maximum monthly snowfall 19.4 in January 1918; maximum snowfall in 24 hours 11.0 in January 1893.

(a) Length of record, years, through the current year unless otherwise noted, based on January data.
(b) 70° and above at Alaskan stations.
* Less than one half.
T Trace.
BLANK entries denote missing or unreported data.

NORMALS - Based on record for the 1951-1980 period.
MEANS - Length of record in (a) is for complete data years.
EXTREMES - Length of record in (a) may be for other than complete or consecutive data years. Date is the most recent in cases of multiple occurrence.
WIND DIRECTION - Numerals indicate tens of degrees clockwise from true north. 00 indicates calm.
FASTEST MILE WIND - Speed is fastest observed 1-minute value when direction is in tens of degrees.

NORMALS, MEANS, AND EXTREMES TABLE NOTE(S):
1. Precipitation data from Dec. 15, 1975 through Oct. 31, 1976 is from North Little Rock.
2. Wind data from Dec. 15, 1975 through Dec. 31, 1976 is from North Little Rock.
3. Maximum in 24 hours precipitation & snow; fastest mile winds; Mean sky cover & days clear-partly cloudy-cloudy are through 1977.

Heating Degree Days

Season	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	Total
1963-64	0	0	4	26	350	973	792	623	876	71	9	0	3229
1964-65	0	0	14	175	336	646	639	604	629	70	0	0	3115
1965-66	0	0	19	137	257	561	916	611	827	119	62	5	2909
1966-67	0	0	3	198	309	679	717	642	460	92	33	0	2913
1967-68	0	0	39	167	472	685	840	220	490	147	20	0	3898
1968-69	0	0	3	124	612	780	860	613	599	108	16	1	3235
1969-70	0	0	6	175	458	769	985	656	516	124	63	0	3402
1970-71	0	0	4	153	442	584	737	523	470	162	90	0	3160
1971-72	0	0	9	8	437	466	659	525	400	149	30	0	2631
1972-73	0	0	8	142	530	736	777	637	216	106	20	0	3260
1973-74	0	0	2	61	263	680	690	533	255	163	4	0	2649
1974-75	0	0	23	111	403	634	630	564	499	196	5	0	3065
1975-76	0	0	48	130	414	683	777	359	284	196	70	0	2909
1976-77	0	0	1	257	567	710	1041	507	265	79	10	0	3423
1977-78	0	0	0	105	370	709	1025	762	436	68	48	0	3623
1978-79	0	0	0	119	321	667	1083	732	314	110	13	0	3458
1979-80	0	0	0	80	436	588	645	695	450	147	15	0	3049
1980-81	0	0	16	184	437	673	774	565	388	37	45	0	3119
1981-82	0	0	4	186	278	668	847	636	290	223	6	0	3166
1982-83	0	0	12	119	369	536	795	587	425	332	31	0	3208
1983-84	0	0	19	89	422	1050							

Cooling Degree Days

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
1969	7	0	0	21	176	506	622	959	273	100	0	0	1991
1970	3	0	0	77	243	416	471	511	409	51	9	9	2199
1971	0	0	11	19	79	435	470	911	355	146	10	3	1939
1972	2	0	3	61	179	440	404	507	341	76	3	0	2113
1973	0	0	34	41	135	415	800	405	330	147	17	0	2090
1974	0	0	45	37	206	288	572	491	148	36	14	0	1787
1975	6	0	4	71	245	416	479	455	178	73	14	2	1941
1976	0	5	27	57	65	292	460	434	220	42	0	0	1602
1977	0	0	7	67	287	455	837	482	377	40	14	0	2266
1978	0	0	9	109	253	424	599	565	357	31	16	0	2359
1979	0	0	24	98	170	396	502	442	240	95	1	0	1926
1980	0	1	1	42	196	439	725	684	492	50	5	0	2479
1981	0	0	9	117	131	458	580	470	318	78	2	0	2163
1982	0	0	57	21	253	353	870	540	294	117	70	24	2240
1983	0	0	0	21	121	481	550	660	355	62	6	0	2157

Snowfall

Season	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	Total
1944-45	0.0	0.0	0.0	0.0	0.0	T	T	0.1	0.0	0.0	0.0	0.0	0.3
1945-46	0.0	0.0	0.0	0.0	0.0	2.0	2.4	3.4	0.0	0.0	0.0	0.0	8.3
1946-47	0.0	0.0	0.0	0.0	0.0	2.5	T	1.3	0.7	0.0	0.0	0.0	7.5
1947-48	0.0	0.0	0.0	0.0	0.0	0.5	4.8	T	T	0.0	0.0	0.0	5.3
1948-49	0.0	0.0	0.0	0.0	T	T	5.0	0.0	T	0.0	0.0	0.0	4.0
1949-50	0.0	0.0	0.0	0.0	0.0	T	2.1	T	T	0.0	0.0	0.0	2.1
1950-51	0.0	0.0	0.0	0.0	T	1.3	3.0	0.1	0.1	0.0	0.0	0.0	4.7
1951-52	0.0	0.0	0.0	0.0	0.4	T	0.0	0.6	0.0	0.0	0.0	0.0	1.0
1952-53	0.0	0.0	0.0	0.0	1.0	T	T	0.0	0.0	0.0	0.0	0.0	1.0
1953-54	0.0	0.0	0.0	0.0	0.0	T	4.0	0.0	0.0	0.0	0.0	0.0	4.0
1954-55	0.0	0.0	0.0	0.0	0.0	T	0.3	0.8	T	0.0	0.0	0.0	1.3
1955-56	0.0	0.0	0.0	0.0	0.0	T	2.0	T	T	0.0	0.0	0.0	2.0
1956-57	0.0	0.0	0.0	0.0	0.0	0.0	T	0.0	T	T	0.0	0.0	T
1957-58	0.0	0.0	0.0	0.0	0.0	T	T	4.2	T	0.0	0.0	0.0	5.0
1958-59	0.0	0.0	0.0	0.0	0.2	5.0	0.2	T	T	0.0	0.0	0.0	5.4
1959-60	0.0	0.0	0.0	0.0	0.0	T	11.6	9.6	5.4	0.0	0.0	0.0	26.6
1960-61	0.0	0.0	0.0	0.0	0.0	6.0	T	T	0.0	0.0	0.0	0.0	6.0
1961-62	0.0	0.0	0.0	0.0	T	T	6.0	T	T	0.0	0.0	0.0	6.0
1962-63	0.0	0.0	0.0	0.0	0.0	1.5	0.7	0.4	T	0.0	0.0	0.0	2.6
1963-64	0.0	0.0	0.0	0.0	0.0	5.8	T	3.2	T	0.0	0.0	0.0	9.0
1964-65	0.0	0.0	0.0	0.0	0.0	0.1	T	2.9	4.3	0.0	0.0	0.0	7.4
1965-66	0.0	0.0	0.0	0.0	0.0	0.0	12.0	9.5	0.0	0.0	0.0	0.0	21.6
1966-67	0.0	0.0	0.0	0.0	T	0.2	1.6	T	T	0.0	0.0	0.0	1.8
1967-68	0.0	0.0	0.0	0.0	T	1.1	1.0	4.3	T	0.0	0.0	0.0	4.4
1968-69	0.0	0.0	0.0	0.0	0.0	0.0	T	T	1	0.0	0.0	0.0	2.3
1969-70	0.0	0.0	0.0	0.0	T	1	4.0	T	T	0.0	0.0	0.0	4.0
1970-71	0.0	0.0	0.0	0.0	0.0	T	T	0.7	7.0	T	0.0	0.0	7.7
1971-72	0.0	0.0	0.0	0.0	4.8	0.6	0.1	0.3	0.0	0.0	0.0	0.0	5.8
1972-73	0.0	0.0	0.0	0.0	T	0.7	2.6	T	0.0	T	0.0	0.0	3.1
1973-74	0.0	0.0	0.0	0.0	0.0	T	0.3	T	0.0	0.0	0.0	0.0	0.3
1974-75	0.0	0.0	0.0	0.0	T	T	1.4	0.4	2.4	0.0	0.0	0.3	4.2
1975-76	0.0	0.0	0.0	0.0	0.2	1.0	T	0.0	0.0	0.0	0.0	0.0	1.2
1976-77	0.0	0.0	0.0	0.0	1.0	0.0	3.8	0.0	0.0	0.0	0.0	0.0	4.8
1977-78	0.0	0.0	0.0	0.0	0.0	0.0	10.0	7.4	T	0.0	0.0	0.0	17.4
1978-79	0.0	0.0	0.0	0.0	0.0	T	1.4	9.7	0.0	0.0	0.0	0.0	11.7
1979-80	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.9	T	T	0.0	0.0	1.8
1980-81	0.0	0.0	0.0	0.0	1.0	T	T	0.0	0.0	0.0	0.0	0.0	1.0
1981-82	0.0	0.0	0.0	0.0	0.0	0.0	5.0	6.0	T	0.0	0.0	0.0	11.3
1982-83	0.0	0.0	0.0	0.0	0.0	T	T	T	T	T	0.0	0.0	T
1983-84	0.0	0.0	0.0	0.0	0.0	0.8							
RECORD MEAN	0.0	0.0	0.0	0.0	0.2	0.8	2.1	1.2	0.5	T	0.0	0.0	4.3

LITTLE ROCK, ARKANSAS

Average Temperature

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1944	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1945	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1946	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1947	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1948	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1949	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1950	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1951	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1952	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1953	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1954	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1955	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1956	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1957	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1958	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1959	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
*1960	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1961	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1962	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1963	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1964	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1965	44.2	43.2	44.5	65.0	72.7	78.2	82.9	81.7	74.3	61.6	56.5	46.7	67.7
1966	35.4	42.9	54.6	62.4	68.4	74.0	84.2	77.9	72.0	59.2	54.8	43.2	61.1
1967	41.7	40.4	58.9	66.7	68.6	79.5	77.9	75.5	69.0	60.9	49.1	42.7	60.9
1968	52.7	58.0	50.0	60.9	67.6	77.0	77.0	81.7	70.7	62.9	51.2	42.2	59.9
1969	43.5	43.0	45.5	61.0	69.9	77.6	89.0	79.0	72.9	62.4	49.4	40.7	60.9
1970	35.7	42.1	48.2	63.1	71.9	78.7	79.9	81.7	78.1	61.5	50.3	47.2	61.5
1971	41.0	44.4	50.0	67.4	68.6	79.3	80.0	78.0	76.4	69.3	50.5	49.9	62.0
1972	43.6	46.7	53.3	62.5	69.0	79.4	80.4	81.1	75.0	62.6	42.3	41.0	62.0
1973	39.7	42.1	56.2	59.9	68.2	78.6	81.1	80.4	75.7	67.6	56.6	42.6	62.6
1974	42.4	45.7	58.1	60.7	71.3	74.3	83.2	79.0	69.0	62.3	51.9	44.4	61.9
1975	44.6	44.6	48.7	60.7	72.5	74.6	80.7	79.5	69.2	63.0	51.4	42.9	61.3
1976	39.7	52.5	56.5	61.1	64.6	74.9	80.2	78.7	72.1	57.8	45.9	71.9	60.4
1977	31.5	46.9	58.4	64.7	73.7	80.0	82.1	80.9	77.3	62.6	52.9	42.0	62.5
1978	31.7	34.0	51.0	65.4	71.4	78.9	84.1	83.0	76.7	62.0	54.6	43.3	61.4
1979	29.4	38.7	55.5	62.7	70.2	77.9	81.0	79.0	72.7	65.3	50.3	45.4	60.7
1980	44.0	40.9	50.3	61.5	70.6	79.4	88.1	87.0	78.6	60.4	50.4	43.1	62.9
1981	39.7	44.6	52.5	67.5	67.4	80.1	83.4	79.9	75.3	61.4	55.5	73.2	62.5
1982	37.5	41.3	57.1	58.0	72.7	76.6	83.1	82.1	74.2	64.7	53.2	48.3	62.4
1983	39.2	43.8	51.1	54.4	67.7	77.4	62.5	66.1	76.0	64.0	50.6	30.9	60.7
RECORD MEAN	41.4	44.6	53.0	62.4	70.2	78.2	81.5	80.6	74.2	63.2	51.9	43.7	67.1
MAX	50.0	55.8	62.7	72.4	79.9	87.0	91.0	90.4	84.4	74.4	61.6	52.3	71.7
MIN	37.7	35.4	43.2	52.4	60.4	68.5	71.4	70.8	64.0	52.4	47.1	35.1	57.5

Precipitation

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1944	2.06	5.98	7.86	9.71	5.02	1.54	3.35	2.82	1.07	0.01	6.08	6.11	48.83
1945	2.26	7.41	6.99	6.61	6.99	7.79	4.57	2.94	9.01	2.20	4.53	1.91	63.26
1946	8.22	5.09	8.22	4.61	4.67	3.39	2.56	0.69	0.83	2.56	7.88	1.23	55.15
1947	2.14	0.51	1.83	6.10	6.07	4.95	1.03	1.09	2.96	5.57	6.27	4.14	43.36
1948	1.56	7.14	6.43	4.54	4.56	2.25	3.41	3.31	1.20	3.11	8.00	2.70	44.21
1949	11.91	4.04	7.33	2.07	2.37	5.71	3.55	6.01	2.75	4.68	0.28	4.78	60.48
1950	12.53	9.27	4.90	2.75	8.37	2.07	1.67	7.54	6.77	1.29	3.90	1.55	67.86
1951	4.32	4.06	1.98	3.61	1.60	4.89	7.60	0.80	4.00	3.71	4.35	5.29	46.43
1952	3.49	5.02	5.61	9.06	4.69	T	2.85	2.50	2.55	0.54	6.84	5.39	43.58
1953	6.11	3.29	9.49	7.24	6.19	0.12	1.19	2.67	1.14	1.07	1.72	2.95	43.17
1954	7.76	3.80	2.14	4.13	6.74	0.63	1.27	0.33	1.78	3.64	1.45	4.15	37.42
1955	1.49	4.24	4.75	3.70	11.55	3.84	2.17	1.77	4.75	1.17	1.80	1.93	42.61
1956	5.77	11.02	2.81	4.64	3.21	5.08	5.47	2.25	0.78	3.04	5.12	2.65	52.94
1957	5.95	5.32	5.12	11.34	11.58	3.39	2.80	4.31	1.96	5.42	9.54	1.84	70.61
1958	4.41	1.93	4.20	8.21	7.84	7.20	3.58	1.80	7.16	0.31	5.15	1.76	55.77
1959	3.58	7.10	3.33	2.57	1.66	6.16	6.36	3.74	7.02	2.07	2.34	8.12	51.60
1960	4.21	4.37	3.67	1.05	5.79	7.25	2.14	2.17	6.23	2.96	1.77	4.09	45.44
1961	0.75	3.65	8.07	3.34	5.68	1.48	2.64	5.14	1.60	0.85	6.11	7.15	44.50
1962	6.84	7.19	5.17	2.90	2.31	6.26	3.10	2.40	3.41	3.54	1.64	1.65	46.68
1963	0.67	2.70	3.81	3.29	1.29	1.29	5.54	0.62	1.01	0.10	4.50	2.48	74.74
1964	0.98	2.07	8.22	11.06	1.40	0.31	3.74	1.71	5.46	0.37	3.70	4.37	46.24
1965	4.45	5.79	3.61	1.19	5.42	7.49	2.51	7.03	7.67	0.21	1.54	2.05	38.92
1966	5.03	5.02	0.71	7.25	2.23	0.69	3.54	14.46	1.47	1.95	3.08	4.21	47.65
1967	2.13	2.31	3.11	7.54	8.69	3.02	4.29	1.73	6.25	4.94	1.73	4.95	50.75
1968	4.76	1.06	5.55	4.05	12.74	6.77	5.94	0.76	5.97	2.61	5.30	4.56	69.65
1969	8.06	2.41	3.65	4.30	3.60	2.78	5.40	7.73	7.31	3.69	3.94	8.10	49.10
1970	1.05	4.57	4.87	7.99	0.69	2.10	3.07	7.15	7.82	7.64	2.09	1.45	41.08
1971	2.07	2.21	3.24	1.70	5.17	7.66	4.01	8.67	0.78	2.55	3.38	6.97	48.56
1972	1.71	1.55	3.32	1.81	2.07	2.67	1.77	1.58	6.41	7.61	7.18	5.14	45.01
1973	5.64	2.75	7.89	14.70	3.96	7.66	6.57	1.26	7.09	5.97	9.03	5.19	74.37
1974	5.77	2.60	2.07	4.76	6.26	1.87	4.04	3.20	4.11	3.36	5.73	7.99	57.96
1975	4.64	4.18	7.67	4.14	5.87	1.56	3.98	2.71	1.46	1.62	3.64	2.92	45.05
1976	3.00	5.17	5.41	1.04	4.88	5.69	1.97	0.70	1.82	6.04	1.79	2.30	39.40
1977	2.70	1.96	6.75	4.47	2.64	4.77	5.07	1.17	4.14	0.67	9.34	1.40	47.66
1978	5.44	1.52	1.56	4.72	6.27	5.34	2.70	6.14	10.17	1.01	6.64	11.26	64.86
1979	9.05	5.67	3.10	9.64	11.54	4.45	4.24	6.51	4.15	3.16	4.07	1.97	64.49
1980	2.73	0.84	6.60	5.85	4.57	3.53	0.49	0.14	5.04	2.64	6.74	1.46	39.72
1981	1.11	3.84	4.00	2.75	9.71	7.80	1.15	2.91	1.37	6.11	1.64	1.34	45.80
1982	8.74	3.37	2.87	9.32	5.61	4.10	1.01	4.57	1.47	2.26	9.12	8.28	61.79
1983	2.25	1.49	4.19	4.72	7.54	1.34	1.07	0.72	0.41	1.77	4.47	4.07	45.11
RECORD MEAN	4.67	1.66	4.44	5.17	5.25	3.71	3.14	3.31	3.35	2.51	4.21	4.22	45.19

FOOTNOTES * Indicates a station move or relocation of instruments.

Record mean values above are means through the current year for the period beginning in 1880 for temperature and precipitation, 1943 for snowfall. Data are from City Office

Alternate Steam Leak Calculations													
NG Balance w/Boiler Data	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total MBtu/yr
Boiler Data for 32, 33 & 34	65,710	58,512	51,989	37,652	34,593	29,844	26,538	24,683	25,268	30,735	42,084	64,506	492,114
Process 31, 32, 33 & 34	10150	10619	12145	10730	10876	11818	12327	10332	10004	10150	9823	10513	129,487
Condensate Losses	4228	3669	3382	2847	2353	2312	2180	1934	2058	2397	3469	4567	35,395
Conduction Losses	4564	4080	4392	4116	4138	3890	3971	3984	3947	4234	4266	4530	50,114
Comfort Heating	35,117	27,788	20,787	6,854	2,517	271	73	137	1,322	7,812	18,317	30,387	151,382
Steam Leaks	11,651	12,356	11,282	13,105	14,709	11,553	7,987	8,297	7,936	6,141	6,209	14,509	125,736

Estimated vs Actual Energy Use													
Estimated NG Use, Mbtu/Mo	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total MBtu/yr
Boiler Data for 32, 33 & 34	65,710	58,512	51,989	37,652	34,593	29,844	26,538	24,683	25,268	30,735	42,084	64,506	492,114
Buildings w/ N.G. Meters	9,187	10,282	7,633	5,274	2,505	3,814	5,233	5,277	4,505	6,079	6,715	9,367	75,872
Area 44 Heating (calc)	1,416	1,087	752	188	54	3	1	1	24	222	644	1,184	5,576
Area 44 Process (calc)	31	28	31	30	31	30	31	31	30	31	30	31	361
Estimated Natural Gas Use	76,344	69,909	60,405	43,144	37,183	33,691	31,802	29,991	29,827	37,067	49,473	75,088	573,923
Actual Natural Gas Use	72,425	65,166	58,220	47,855	37,697	38,392	37,838	34,199	35,284	41,937	58,597	77,672	605,282
Percent Difference	5%	7%	4%	-10%	-1%	-12%	-16%	-12%	-15%	-12%	-16%	-3%	-5%

PINE BLUFF ARSENAL												
Sum of Areas 32,33,34 '95 nat. gas consumption (CF/D x 1000) = (MB/D)												
Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	2,036	2,037	2,386	1,291	1,245	1,089	856	998	766	874	1,336	1,771
2	1,894	1,902	2,302	1,248	1,426	945	846	832	728	899	1,255	1,552
3	2,045	2,060	2,063	1,311	1,261	1,000	872	853	736	980	1,338	1,669
4	2,220	2,135	2,206	1,533	1,200	1,262	812	896	800	1,013	1,423	1,842
5	2,310	1,884	1,999	1,347	1,156	1,178	1,043	806	658	938	1,183	1,754
6	2,379	2,204	1,513	1,313	1,196	1,038	881	737	804	974	1,377	2,148
7	2,277	2,250	2,328	1,380	1,119	1,037	892	756	826	973	1,324	2,091
8	2,131	2,287	2,182	1,285	1,133	1,025	892	749	793	819	1,515	1,943
9	2,111	2,355	2,238	1,275	1,112	853	823	804	849	909	1,372	2,109
10	1,879	2,064	1,948	1,309	1,146	1,036	784	804	795	881	1,171	2,098
11	1,745	1,985	1,797	1,355	1,099	850	783	1,319	821	949	834	2,224
12	1,731	2,420	1,577	1,370	1,186	1,007	739	845	655	950	1,035	2,080
13	1,821	2,272	1,751	1,238	1,001	928	750	793	833	954	1,528	1,939
14	1,923	2,327	1,564	1,332	984	938	752	785	802	1,055	1,482	1,742
15	1,823	2,161	1,601	1,318	1,046	960	788	786	826	905	1,326	1,723
16	1,776	2,244	1,658	1,081	988	1,019	744	738	838	948	1,518	1,785
17	1,976	2,149	1,423	1,274	808	964	819	720	775	963	1,448	1,852
18	2,105	2,276	1,429	1,143	1,078	861	781	679	850	954	1,269	2,067
19	2,462	2,044	1,440	1,211	1,130	970	770	724	844	1,009	1,559	2,401
20	1,907	2,029	1,464	1,193	1,015	978	863	680	898	1,017	1,438	2,536
21	2,308	2,025	1,486	1,160	1,144	1,073	857	709	983	1,004	1,431	2,286
22	2,287	1,988	1,376	1,270	1,091	951	811	747	949	956	1,269	2,163
23	2,330	1,862	1,442	1,246	1,081	1,057	897	761	997	1,007	1,274	2,280
24	2,239	1,885	1,303	1,241	1,148	898	873	787	977	1,122	1,407	2,236
25	2,276	1,850	1,228	1,177	1,063	1,049	1,037	805	1,025	1,112	1,507	2,326
26	2,172	1,869	1,276	1,220	927	997	880	847	1,011	1,058	1,251	2,349
27	2,145	1,836	1,346	1,268	1,137	990	905	589	941	1,010	1,574	2,439
28	2,336	2,112	1,394	1,118	1,051	992	939	777	969	1,054	1,874	2,304
29	2,417	0	1,417	1,019	1,230	995	1,051	697	651	911	1,860	2,321
30	2,464	0	1,452	1,126	1,277	904	916	871	868	1,319	1,906	2,336
31	2,185	0	1,400	0	1,115	0	882	789	0	1,218	0	2,140
Sum	65,710	58,512	51,989	37,652	34,593	29,844	26,538	24,683	25,268	30,735	42,084	64,506

PINE BLUFF ARSENAL

Bldg 32-060 '95 Nat. Gas Consumption (CF/D x 1000) = (MB/D)

Date/Mo.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	830	653	906	353	326	390	419	359	389	0	494	468
2	676	621	844	367	480	426	439	342	337	0	420	347
3	813	1,019	737	384	311	470	446	359	349	0	403	394
4	927	979	730	426	294	410	407	377	349	389	304	435
5	767	553	658	443	263	280	475	313	120	427	331	445
6	1,030	758	549	416	404	331	420	261	0	425	415	585
7	951	766	987	443	289	336	437	280	0	422	391	524
8	907	796	809	361	359	317	442	263	0	383	460	512
9	694	787	879	377	394	379	416	297	0	429	401	646
10	659	694	660	351	363	527	343	281	0	427	254	626
11	650	795	638	393	371	403	343	796	0	428	0	737
12	611	929	413	411	363	346	316	298	0	469	133	688
13	624	876	677	307	450	342	320	309	0	444	458	608
14	747	854	474	374	421	357	291	303	0	397	374	481
15	689	730	497	380	313	349	313	217	0	267	253	480
16	630	770	650	283	334	369	267	269	0	301	476	535
17	820	720	501	276	309	373	273	288	0	319	455	557
18	834	778	397	285	421	321	340	274	0	323	386	693
19	868	607	388	324	329	320	338	334	0	327	414	904
20	0	710	316	307	311	341	370	239	0	353	443	983
21	606	644	436	313	360	530	0	296	0	324	434	961
22	624	653	373	338	337	491	0	296	0	311	477	838
23	833	584	399	326	334	546	356	297	0	333	610	898
24	784	700	320	326	339	394	343	309	0	353	771	846
25	903	561	318	336	330	469	407	314	0	356	918	895
26	1,054	577	310	314	470	362	346	366	0	373	695	940
27	1,017	627	301	320	530	450	342	283	0	358	764	870
28	1,251	759	359	258	527	351	401	420	0	307	927	852
29	1,083		339	311	484	371	397	323	0	253	624	874
30	843		370	309	462	413	390	373	0	479	474	909
31	680		351		381		373	375	0	405		769
Sum	24,405	20,500	16,586	10,412	11,659	11,764	10,770	10,111	1,544	10,382	13,959	21,300

PINE BLUFF ARSENAL												
Bldg 33-060 '95 nat. gas consumption (CF/D x 1000) = (MB/D)												
Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	587	427	509	343	396	324	437	0	0	354	381	399
2	526	391	487	280	394	519	407	0	0	396	348	441
3	623	0	437	304	400	530	426	0	0	432	444	452
4	626	130	483	383	403	409	405	0	0	70	436	534
5	604	413	450	331	343	434	568	0	280	0	362	500
6	686	500	380	350	474	372	461	0	367	0	421	570
7	659	477	444	377	306	347	455	0	343	0	407	608
8	581	481	481	414	331	357	450	0	358	0	485	500
9	533	488	463	387	281	474	407	0	331	0	384	495
10	557	471	401	457	382	509	0	0	293	0	310	501
11	519	478	388	386	339	447	0	0	307	0	0	497
12	546	414	360	358	373	661	0	0	302	0	46	421
13	587	445	431	318	417	586	0	0	339	0	401	355
14	556	491	416	361	297	581	0	0	319	243	394	410
15	561	534	444	360	298	611	0	0	339	273	406	381
16	546	550	406	277	236	650	0	0	341	254	462	376
17	557	543	373	468	309	591	0	0	319	264	440	348
18	647	569	414	437	311	540	0	0	340	260	397	395
19	771	511	413	341	451	650	0	0	337	301	364	454
20	725	417	476	313	417	637	0	0	363	273	446	493
21	653	476	387	313	404	543	276	0	409	270	428	451
22	611	457	374	341	417	460	371	0	388	260	148	481
23	521	423	421	346	423	511	49	0	475	287	0	490
24	499	477	324	351	454	504	0	0	436	375	0	496
25	646	446	280	297	424	580	0	0	444	315	0	533
26	664	464	377	379	457	635	0	0	450	278	0	512
27	472	433	409	388	607	540	0	0	410	280	0	625
28	31	449	383	360	524	641	0	0	456	310	0	574
29	473		420	257	555	624	0	0	0	267	292	573
30	541		446	311	388	491	0	0	398	387	497	533
31	486		412		316		0	0		353		489
Sum	17,594	12,355	12,889	10,588	12,127	15,758	4,712	0	9,144	6,502	8,699	14,887

PINE BLUFF ARSENAL												
Bldg 34-140 '95 nat. gas consumption (CF/D x 1000) = (MB/D)												
Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	619	957	971	595	523	375	0	639	377	520	461	904
2	692	890	971	601	552	0	0	490	391	503	487	764
3	609	1041	889	623	550	0	0	494	387	548	491	823
4	667	1026	993	724	503	443	0	519	451	554	683	873
5	939	918	891	573	550	464	0	493	258	511	490	809
6	663	946	584	547	318	335	0	476	437	549	541	993
7	667	1007	897	560	524	354	0	476	483	551	526	959
8	643	1010	892	510	443	351	0	486	435	436	570	931
9	884	1080	896	511	437	0	0	507	518	480	587	968
10	663	899	887	501	401	0	441	523	502	454	607	971
11	576	712	771	576	389	0	440	523	514	521	834	990
12	574	1077	804	601	450	0	423	547	353	481	856	971
13	610	951	643	613	134	0	430	484	494	510	669	976
14	620	982	674	597	266	0	461	482	483	415	714	851
15	573	897	660	578	435	0	475	569	487	365	667	862
16	600	924	602	521	418	0	477	469	497	393	580	874
17	599	886	549	530	190	0	546	432	456	380	553	947
18	624	929	618	421	346	0	441	405	510	371	486	979
19	823	926	639	546	350	0	432	390	507	381	781	1043
20	1182	902	672	573	287	0	493	441	535	391	549	1060
21	1049	905	663	534	380	0	581	413	574	410	569	874
22	1052	878	629	591	337	0	440	451	561	385	644	844
23	976	855	622	574	324	0	492	464	522	387	664	892
24	956	708	659	564	355	0	530	478	541	394	636	894
25	727	843	630	544	309	0	630	491	581	441	589	898
26	454	828	589	527	0	0	534	481	561	407	556	897
27	656	776	636	560	0	0	563	306	531	372	810	944
28	1054	904	652	500	0	0	538	357	513	437	947	878
29	861		658	451	191	0	654	374	651	391	944	874
30	1080		636	506	427	0	526	498	470	453	935	894
31	1019		637		418		509	414		460		882
Sum	23,711	25,657	22,514	16,652	10,807	2,322	11,056	14,572	14,580	13,851	19,426	28,319

A.5 ECO CALCULATIONS, COST ESTIMATES AND BACKUP DATA

ECO-E1

Replace compressor motors in Buildings 32-060, 33-060 and 34-140 with energy efficient motors.

Reynolds, Smith and Hills, Inc.
Architectural, Engineering, Planning and Environmental Services

Telephone Call Confirmation

Date: June 18, 1996

Project Number: 694-1331-004
Project Name: Pine Bluff Arsenal Heating and Electric Study
Received: **Placed:** by W. Todd
Local: **Long Dist.:** Yes
Conversed with: Representatives
of GE, Reliance, MSC Ind., Atlas Copco

Regarding: Energy efficient replacement for synchronous compressor motors.

General Electric - Motor Supply Center (800)243-7313: Spoke with Julie; GE no longer makes synchronous motors in sizes less than 600 HP. They also do not manufacture any other type of motor that could replace the existing motors. They can custom manufacturer motors but the minimum order is 50 units and the cost would be fairly high. She suggested I try MSC Industrial and Atlas Copco.

Reliance Electric (800)245-4501: Referred me to local distributor at 724-7080: They do not manufacture any synchronous motors over 5 HP.

Westinghouse Motor Company (800)451-8798: Referred to Brent Ferrel; left message explaining what I am looking for on Brent's voice mail.

MSC Industrial (800)645-7270: Spoke with Karen; MSC is a distribution company for various motor manufacturers. They do not have any synchronous motors in that size range.

Atlas Copco (412)749-0710: Spoke with Mike; they manufacture servo motors and do not have any motors that can replace the existing motors.

Distribution: C. Warren
File

By William T. Todd, PE

A.5.E1-2

Table 15.1.14 Performance Data for Coupled Synchronous Motors

hp	Poles	r/min	A	Excitation, kW	Efficiencies, percent ½ load	¾ load	Full load	Weight, lb
Unity power factor, 3 phase, 60 Hz, 2,300 V								
500	4	1,800	100	3	94.5	95.2	95.3	5,000
2,000	4	1,800	385	9	96.5	97.1	97.2	15,000
5,000	4	1,800	960	13	96.5	97.3	97.5	27,000
10,000	6	1,200	1,912	40	97.5	97.9	98.0	45,000
500	18	400	99.3	5	92.9	93.9	94.3	7,150
1,000	24	300	197	8.4	93.7	94.6	95.0	15,650
4,000	48	150	781	25	94.9	95.6	95.6	54,000
80% power factor, 3 phase, 60 Hz, 2,300 V								
500	4	1,800	127	4.5	93.3	94.0	94.1	6,500
2,000	4	1,800	486	13	95.5	96.1	96.2	24,000
5,000	4	1,800	1,212	21	95.5	96.3	96.5	37,000
10,000	6	1,200	2,405	50	96.8	97.3	97.4	70,000
500	18	400	125	7.2	92.4	93.4	93.6	9,500
1,000	24	300	248	11.6	93.3	94.2	94.4	17,500
4,000	48	150	982	40	94.6	95.3	95.5	11,500

SOURCE: Westinghouse Electric Corp.

loss, the disk follows the field just as the rotor of an induction motor does. When the rotor approaches the synchronous speed of 3,600 r/min, the rotating magnetic field takes a path along the two rotor bars and locks the rotor in with it. The rotor and the necessary train of reducing gears rotate in oil sealed in a small metal can. Figure 15.1.74*b* shows a subsynchronous motor. Six squirrel-cage bars are inserted in six slots of a solid cylindrical iron rotor, and the spaces between the slots form six salient poles. The motor, because of the squirrel cage, starts as an induction motor, attempting to attain the speed of the rotating field, or 3,600 r/min (at 60 Hz). However, when the rotor reaches 1,200 r/min, one-third synchronous speed, the salient poles of the rotor lock in with the poles of the stator and hold the rotor at 1,200 r/min.

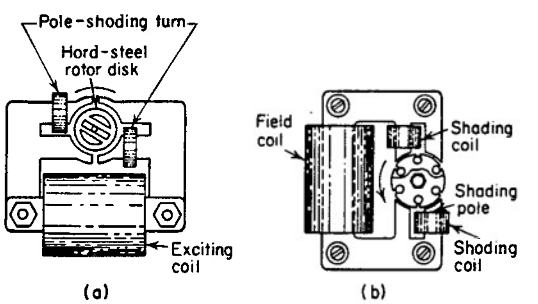


Fig. 15.1.74 Synchronous motors for timing. (*a*) Warren Telechron motor; (*b*) Holtz induction-reluctance subsynchronous motor.

AD-DC CONVERSION

Static Rectifiers

Silicon devices, and to a lesser extent gas tubes, are the primary means of ac to dc or dc to ac conversion in modern installations. They are advantageous when compared to synchronous converters or motor generators because of efficiency, cost, size, weight, and reliability. Various bridge configurations for single-phase and three-phase applications are shown in Fig. 15.1.75*a*. Table 15.1.15 shows the relative outputs of rectifier circuits. The use of two three-phase bridges fed from an ac source consisting of a three-winding transformer with both a Δ and Y secondary winding so that output voltages are 30° out of phase will reduce dc ripple to approximately 1 percent.

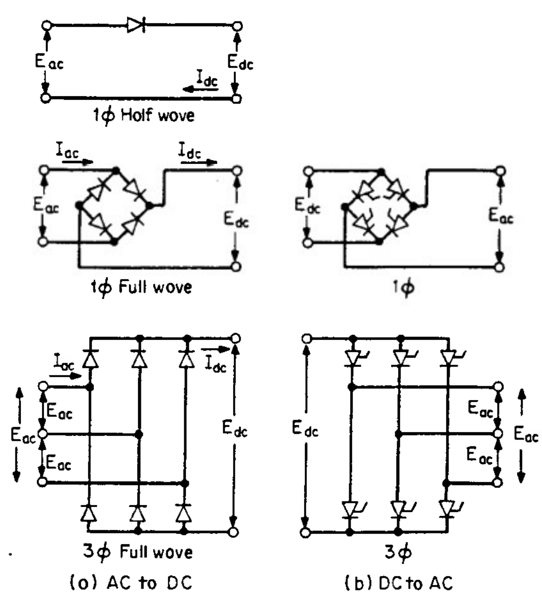


Fig. 15.1.75 AC-DC conversion with static devices.

A.5.E1-3

ELECTRIC MOTOR DATA SHEET

Survey Date: 1/30/96; Survey By: CSW

Equipment ID/Function: Compressor No. 1

Location: Building 32060

Nameplate Data:

Manufacturer: General Electric

Model No.: 53R884A60; Serial No.: ____

Insulation Class: ____; NEMA Design: ____; Code: ____; Efficiency: ____

Horsepower 150; Frame 965Y; RPM 600; Service Factor ____

Volts 460; Amps 192; Phases 3; Hz 60; PF ____; kW ____

Type: Synchronous ✓; Induction ____; Other ____

For Synchronous Motors: DC Excitation Volts 125; Amps 33

Electrical Measurements:

Measurements	Phase	Phase	Phase	Phase	Phase	Phase
Volts(rms)	295.1	295.9	273.5			
Amps(rms)	170.8	164.8	156.4			
kW	22.42	24.33	34.52			
kVAR	36.99 Le	40.58 Le	35.79 Le			
kVA	43.33	47.54	49.80			
Power Factor	0.51	0.51	0.69			
dPF	0.51	0.51	0.69			
kdVA	2.616	4.580	2.630			

General Condition/Comments: ____

ELECTRIC MOTOR DATA SHEET

Survey Date: 1/30/96; Survey By: CSW

Equipment ID/Function: Compressor No. 2

Location: Bldg. 32060

Nameplate Data:

Manufacturer: General Electric

Model No.: 35R684A60; Serial No.: ______

Insulation Class: ____; NEMA Design: ____; Code: A; Efficiency: ______

Horsepower 173; Frame 965Y; RPM 600; Service Factor ______

Volts 460; Amps 206; Phases 3; Hz 60; PF ______; kW ______

Type: Synchronous ✓; Induction ______; Other ______

For Synchronous Motors: DC Excitation Volts 125; Amps 33

Electrical Measurements:

Measurements	Phase	Phase	Phase	Phase	Phase	Phase
Volts(rms)						
Amps(rms)						
kW						
kVAR						
kVA						
Power Factor						
dPF						
kdVA						

General Condition/Comments: Valves being repaired - motor not operational during survey

ECO-E2

Replace the WP pollution abatement system scrubber/exhaust fan motors with energy efficient motors.

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: ECO-E2
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID FY95 (92)

INSTALLATION & LOCATION: PINE BLUFF ARS REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: ECO-E2 EFFICIENT MOTORS FOR WP SCRUBBER FANS
FISCAL YEAR 1997 DISCRETE PORTION NAME: COMPLETE PROJECT
ANALYSIS DATE: 07-01-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

A. CONSTRUCTION COST	$ 104945.		
B. SIOH	$ 6297.		
C. DESIGN COST	$ 6297.		
D. TOTAL COST (1A+1B+1C)	$ 117539.		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F. PUBLIC UTILITY COMPANY REBATE		$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 117539.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 16.79	169.	$ 2836.	15.08	$ 42764.
B. DIST	$ .00	0.	$ 0.	18.57	$ 0.
C. RESID	$ .00	0.	$ 0.	21.02	$ 0.
D. NAT G	$ 2.81	0.	$ 0.	18.58	$ 0.
E. COAL	$ .00	0.	$ 0.	16.83	$ 0.
F. PPG	$ .00	0.	$ 0.	17.38	$ 0.
M. DEMAND SAVINGS			$ 0.	14.88	$ 0.
N. TOTAL		169.	$ 2836.		$ 42764.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ 0.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 2836.

5. SIMPLE PAYBACK PERIOD (1G/4) 41.45 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 42764.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= .36
(IF < 1 PROJECT DOES NOT QUALIFY)

ECO - E2 REPLACE WP SCRUBBER/EXH. FAN MOTORS

The existing motors are 800 hp Armor Line by Louis Allis. See nameplate data on attached sheet. There are two fans and two motors but only one operates at any time. The other is alternated into service. The fan and motor only run during WP production.

The attached WP Production Schedule shows the monthly production hours for Feb '95 - Jan '96. The total operating hours for this period is 550 hours/year.

The motor control panel meters indicated:

Feed 1	2750 V	95 A
Feed 2	2625 V	100 A
Feed 3	2750 V	90 A

The amperages seem reasonable but the voltage is way out of range for a 2300 V motor. The motor kw calculation will assume the input voltage is 2300.

$$kw = \frac{2300\,v \times 95A + 2300\,v \times 100A + 2300\,v \times 90A}{1000\ w/kw} = 655.5\ kW$$

Based on age and size the following assumptions were made to perform the energy savings calculations:

Existing Motor Efficiency = 90 %

Existing Motor Power Factor = 0.88

ECO CALCULATIONS
Energy Efficient Motors

Project:	WP Scrubber/Exhaust Fans	RSH No.:	6941331004
Location:	Pine Bluff Arsenal, AR	Date:	6/21/96
ECO No.:	E2	Designer:	W. Todd

Assumptions:	(1)	Motor nameplate horsepower =	800	(Name plate data)
	(2)	Efficiency of existing motor =	90%	(Estimated)
	(3)	Exist. motor electric data:	2300 V	(Name plate data)
			185 A	"
			3 ph	"
			0.88 pf	(Estimated)
	(4)	Measured/estimated kW =	655.5	(Calc from PBA meters)
	(5)	Avg. annual operaing hours =	550	(Operating Staff)
	(6)	New motor premium efficiency =	96%	(Vendor Data)

$$\text{Max kW of existing motor} = \frac{2300\ \text{V} \times 185\ \text{A} \times 1.732 \times 0.88}{0.90 \times 1000} = 720.6\ \text{kW}$$

$$\text{Percent operating load} = \frac{655.5\ \text{kW}}{720.6\ \text{kW}} = 91.0\%$$

$$\text{Operating kW of new motor} = \frac{800\ \text{hp} \times 0.910 \times 0.7457\ \text{kW/bhp}}{0.96} = 565.5\ \text{kW}$$

$$\text{Electric Demand Savings} = 655.5\ \text{kW} - 565.5\ \text{kW} = 90.0\ \text{kW}$$

$$\text{Electric Energy Savings} = 90.0\ \text{kW} \times 550\ \text{Hr/Yr} = 49{,}500\ \text{kWh/Yr}$$

$$\text{Electric Energy Savings} = 49{,}500\ \text{kWh/Yr} \times 0.003413\ \frac{\text{MBtu}}{\text{kWh}} = 168.9\ \text{MBtu/Yr}$$

E2-CALC1.XLS

CONSTRUCTION COST ESTIMATE

Project:	Energy Efficient Motors - WP Scrubber/Exhaust Fans	RS&H No.:	694-1331-004
Location:	Pine Bluff Arsenal, AR	Date:	6/21/96
Basis:	Schematic Design	Estimator:	W. Todd
ECO Number:	E2	Filename:	EST-E2.XLS

ITEM DESCRIPTION	QUANTITY No.	QUANTITY Unit	MATERIAL/EQUIP $/Unit	MATERIAL/EQUIP Total	LABOR $/Unit	LABOR Total	TOTAL COST	SOURCE Material	SOURCE Labor
Remove 800 HP Motors	4.00	Ton		0	395	1,580	1,580		MMp21 (1)
800 HP High efficiency motor	2	Ea	40640	81,280	1880	3,760	85,040	Vendor	MEp199 (2)
Overload Thermal Units	6	Ea	9	54	4.88	29	83	SDp23-18	Note (3)
Electrical Connection	2	Ea		0	624	1,248	1,248		MEp124 (2)
Subtotal Bare Costs				81,334		6,617	87,951		
Retrofit Cost Factors			0%	0	0%	0	0	MMp6	MMp6
Subtotal				81,334		6,617	87,951		
City Cost Index			0.952	(3,904)	0.632	(2,435)	(6,339)	MMp533	MMp533
Subtotal				77,430		4,182	81,612		
OH & Profit Markups			10%	7,743	53%	2,216	9,959	MMp7	MMp475
Subtotal				85,173		6,398	91,571		
State Sales Taxes			4.5%	3,833		N.A.	3,833	MMp476	
Subtotal				89,006		6,398	95,404		
Contingency			10%	8,901	10%	640	9,541	MEp6	MEp6
Total Construction Cost				**97,907**		**7,038**	**$104,945**		
Design Fee				N.A.	6.0%	6,297	6,297		
SIOH				N.A.	6.0%	6,297	6,297		
Total Project Cost				**97,907**		**19,632**	**$117,539**		

LEGEND:

Note (1)	Assumes each motor weighs 4000 pounds.
Note (2)	Assumes 10 minutes to install each thermal unit.
Note (3)	Used installation cost for 200 HP motor x 800/200.
MEp###	1996 Means Electrical Cost Data, page ###.
MMp###	1996 Means Mechanical Cost Data, page ###.
SDp###	Square-D Digest Number 170, page ###.

ELECTRIC MOTOR DATA SHEET

Survey Date: 3/28/96; Survey By: WTT

Equipment ID/Function: WP Exhaust / scrubber Fan

Location: Outside Building 34-196

Nameplate Data:

Manufacturer: Louis Allis, Armor Line Motors

Model No.: TYPE WP IIS; Serial No.: 727977 8002

Insulation Class: B; NEMA Design: ____; Code: ____; Efficiency: ____

Horsepower 800; Frame 711 OEL; RPM 1775; Service Factor 1.0

Volts 2300; Amps 185; Phases 3; Hz 60; PF ____; kW ____

Type: Synchronous ____; Induction ✓; Other ____

For Synchronous Motors: DC Excitation Volts ____; Amps ____

Electrical Measurements: (Readings from motor control panel)

Measurements	Phase 1-2	Phase 2-3	Phase 3-1	Phase	Phase	Phase
Volts(rms)	2750	2625	2750			
Amps(rms)	95	100	90			
kW						
kVAR						
kVA						
Power Factor						
dPF						
kdVA						

General Condition/Comments: Not operating during survey. There are two of these fans, only one is used at a time.

SIOPB-PWN 5 March 1996

WP Production Schedule

	No. Shifts Per Month	Hrs Worked Per Shift	Hrs Worked Per Month
Feb 95	8	10	80
Mar 95	11	10	110
Apr 95	5	10	50
May 95	4	10	40
Jun 95	11	10	110
Jul 95	12	10	120
Aug 95	1	10	10
Sep 95	1	10	10
Oct 95	0	0	0
Nov 95	0	0	0
Dec 95	2	10	20
Jan 96	0	0	0
Feb 96	0	0	0
	55 shifts	TOTAL HRS WORKED:	550

NOTE: Each shift consists of 10 hrs, 0630 - 1700 hrs, four days/week.

A.5.E2-7

The LOUIS ALLIS Company

TO: REYNOLDS SMITH & HILLS
PH: 904-279-2281
FAX: 904-279-2491

FROM: BOB BROTHERHOOD
X-315

ATTENTION: BILL TODD

YOUR REFERENCE: PHONE CALL OF 6/18/96

DATE: JUNE 21, 1996

OUR PROPOSAL: 5235 RB

CC: BILL TAYLOR -
TAYLOR INDUSTRIAL SALES
FAX: 813-247-7630

* *

STANDARD LOUIS ALLIS TERMS AND CONDITIONS OF SALES, FORM TC 9/95 TO APPLY.

NORMAL TRANSPORTATION: PREPAID AND ADDED TO INVOICE, LOUIS ALLIS WILL SELECT METHOD AND ROUTING. F.O.B. POINT OF SHIPMENT.

TERMS OF PAYMENT - NET 30 DAYS.

QUOTATIONS OF $100,000 OR GREATER WILL BE SUBJECT TO PROGRESS PAYMENTS TO EIGHTY PERCENT OF THE QUOTED PRICE PRIOR TO SHIPMENT.

THIS QUOTATION IS VOID UNLESS ACCEPTED WITHIN 30 DAYS FROM DATE HEREOF AND IS SUBJECT TO MODIFICATION UPON NOTICE. IT SUPERSEDES ALL PREVIOUS QUOTATIONS AND AGREEMENTS RELATING TO THIS TRANSACTION.

FOR CUSTOMERS OUTSIDE THE UNITED STATES AND CANADA, OR EXPORT COMPANIES, OR ANY CUSTOMERS WHOSE CREDIT IS NOT ACCEPTABLE TO LOUIS ALLIS. PAYMENT IS TO BE BY IRREVOCABLE BANK LETTER OF CREDIT NAMING LOUIS ALLIS AS BENEFICIARY, THE LETTER OF CREDIT MUST BE VALID AT LEAST ONE YEAR. THIS LETTER OF CREDIT MUST BE PRESENTED AT THE TIME OF ORDER ENTRY.

THIS QUOTATION IS CONDITIONED UPON THE TERMS CONTAINED HEREIN AND REFERENCED ABOVE. ANY ADDITIONAL OR DIFFERENT TERMS PROPOSED BY BUYER ARE OBJECTED TO AND WILL NOT BE BINDING UPON SELLER UNLESS SPECIFICALLY ASSENTED TO IN WRITING BY SELLER'S AUTHORIZED REPRESENTATIVE.

SINCERELY,

Bob

BOB BROTHERHOOD / ASSISTANT PRODUCT MANAGER

427 East Stewart Street • P.O. Box 2020 • Milwaukee, WI 53201
(414) 481-6000 • Fax (414) 481-2622

M5844-10/95-5

A.5.E2-8

YOUR REFERENCE: PHONE CALL OF 6/18/96

OUR PROPOSAL NO.: 5235 RB

WE ARE PLEASED TO SUBMIT THE FOLLOWING QUOTATION:

ITEM A QTY 2 - 800 HP, 1800 RPM, WPII ENCLOSURE

BALL BEARINGS, 2300/3/60 INPUT, 7110EL FRAME .... $40,640.00 NET EACH

SHIPMENT: 14-16 WEEKS AFTER RECEIPT OF PURCHASE ORDER AND ANY OUTSTANDING APPLICATION INFORMATION

COMMENTS:

REPLACEMENT FOR UNITS BUILT ON S/N 7-279778-001 & 002.

NEW UNITS WILL HAVE SAME SHAFT EXTENSION AND MOUNTING DIMENSIONS AS ORIGINAL UNITS.

NEW UNITS INCLUDES MORE ELECTRICAL MATERIAL AND A COPPER BAR ROTOR TO INCREASE EFFICIENCY.

PRICE INCLUDES OVERSIZED CONDUIT BOX CONTAINING LIGHTNING ARRESTORS AND SURGE CAPACITORS, SPACE HEATERS, STATOR RTD'S, AND SPECIAL PAINT.

NOTE:

1. PAINT SYSTEM USED ON ORIGINAL UNITS IS NO LONGER AVAILABLE. OUR PRICE HOWEVER DOES INCLUDE AN INORGANIC ZINC PAINT SYSTEM.

2. PRICE DOES NOT INCLUDE A SOLEPLATE OR PRESSING ON A HALF COUPLING, AS WAS INCLUDED ON ORIGINAL UNITS.

A.5.E2-9

OUR PROPOSAL NO.: 5235 RB

FOLLOWING IS TYPICAL DATA:

ITEM		A
HP		800
ENCLOSURE		WPII
FRAME		7110EL
EFF/PF	1/2 LOAD	.964 / .815
	3/4 LOAD	.963 / .87
	4/4 LOAD	.959 / .885
FULL LOAD RPM		1784
% LOCKED TORQUE		125
% DIP (MIN) TORQUE		110
% BREAKDOWN TORQUE		235
LOCKED AMPS		1075
FULL LOAD AMPS		177
ROTOR INERTIA (#FT2)		180
SAFE LOCKED TIME (SEC)		11

A.5.E2-10

ECO-E3

Replace raw water pump motors in Buildings 42-010, 42-020 and 42-030 with energy efficient motors.

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-E3
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: P B ARSENAL REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: ECO-E3 EFFICIENT MOTORS FOR RAW WATER PUMPS
FISCAL YEAR 1997 DISCRETE PORTION NAME: COMPLETE PROJECT
ANALYSIS DATE: 07-01-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

A. CONSTRUCTION COST	$ 23838.			
B. SIOH	$ 1431.			
C. DESIGN COST	$ 1431.			
D. TOTAL COST (1A+1B+1C)	$ 26700.			
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$	0.	
F. PUBLIC UTILITY COMPANY REBATE		$	0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)				$ 26700.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 16.79	123.	$ 2058.	15.08	$ 31041.
B. DIST	$ .00	0.	$ 0.	18.57	$ 0.
C. RESID	$ .00	0.	$ 0.	21.02	$ 0.
D. NAT G	$ 2.81	0.	$ 0.	18.58	$ 0.
E. COAL	$ .00	0.	$ 0.	16.83	$ 0.
F. PPG	$ .00	0.	$ 0.	17.38	$ 0.
M. DEMAND SAVINGS			$ 0.	14.88	$ 0.
N. TOTAL		123.	$ 2058.		$ 31041.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 0.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 2058.

5. SIMPLE PAYBACK PERIOD (1G/4) 12.97 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 31041.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 1.16
(IF < 1 PROJECT DOES NOT QUALIFY)

RS&H

SUBJECT	PBA ELEC + HTG STUDY RAW WATER PUMP MOTORS	AEP NO	694-1331-004
		SHEET	OF
DESIGNER	W. TODD	DATE	6-20-96
CHECKER		DATE	

ECO-E3 Energy Efficient Motors for Raw water Pumps

There are 3 raw water pump that are alternated into service every third day. They are used to pump ground water into the treatment plant holding tanks.

The motors are 150 hp, std. eff. induction motors. See Electric Motor Data Sheets attached.

Actual operating hours were obtained from the water plant staff. See attached Message from G. Burris.

Based on a C/S Engineer graph the efficiency of the two older motors is estimated to be ~ 92%.

Based on new GE data for standard eff. motors (Grainger No. 386, P. 15), the new 150 hp pump motor efficiency is ~ 94%.

Energy savings calculations from the attached spreadsheets give the following results for using new eff. motors for these pumps:

$$\text{Energy Savings} = (44.8 + 45.0 + 32.8)\frac{\text{MBtu}}{\text{YR}} = \underline{122.6\ \frac{\text{MBtu}}{\text{YR}}}$$

CONSTRUCTION COST ESTIMATE

Project:	Energy Efficient Motors - Raw Water Pumps	RS&H No.:	694-1331-004
Location:	Pine Bluff Arsenal, AR	Date:	6/19/96
Basis:	Schematic Design	Estimator:	W. Todd
ECO Number:	E3	Filename:	EST-E3.XLS

ITEM DESCRIPTION	QUANTITY		MATERIAL/EQUIP		LABOR		TOTAL COST	SOURCE	
	No.	Unit	$/Unit	Total	$/Unit	Total		Material	Labor
Remove 150 HP Motors	3.03	Ton		0	395	1,197	1,197		MMp21
150 HP Premium Eff. Motor	3	Ea	4980	14,940	390	1,170	16,110	GRp27	MEp199
Restricted Area Handling	3	Ea		0	1000	3,000	3,000		MEp199
Overload Thermal Units	9	Ea	9	81	4.88	44	125	SDp23-18	Note (1)
Subtotal Bare Costs				15,021		5,411	20,432		
Retrofit Cost Factors			0%	0	0%	0	0	MMp6	MMp6
Subtotal				15,021		5,411	20,432		
City Cost Index			0.952	(721)	0.632	(1,991)	(2,712)	MMp533	MMp533
Subtotal				14,300		3,420	17,720		
OH & Profit Markups			10%	1,430	53%	1,813	3,243	MMp7	MMp475
Subtotal				15,730		5,233	20,963		
State Sales Taxes			4.5%	708		N.A.	708	MMp476	
Subtotal				16,438		5,233	21,671		
Contingency			10%	1,644	10%	523	2,167	MEp6	MEp6
Total Construction Cost				**18,082**		**5,756**	**$23,838**		
Design Fee				N.A.	6.0%	1,430	1,430		
SIOH				N.A.	6.0%	1,430	1,430		
Total Project Cost				**18,082**		**8,616**	**$26,698**		

LEGEND:

Note (1)	Assumes 10 minutes to install each thermal unit.
GRp###	Grainger General Catalog Number 386, page ###.
MEp###	1996 Means Electrical Cost Data, page ###.
MMp###	1996 Means Mechanical Cost Data, page ###.
SDp###	Square-D Digest Number 170, page ###.

ECO CALCULATIONS
Energy Efficient Motors

Project:	Raw Water Pump - Bldg. 42-010	RSH No.:	6941331004
Location:	Pine Bluff Arsenal, AR	Date:	6/20/96
ECO No.:	E3	Designer:	W. Todd

Assumptions:	(1)	Motor nameplate horsepower =	150	(Name plate data)
	(2)	Efficiency of existing motor =	92%	(C/S Engineer Article)
	(3)	Exist. motor electric data:	440 V	(Name plate data)
			180 A	"
			3 ph	"
			0.86 pf	(Estimated)
	(4)	Measured/estimated kW =	122.5	(Field Measurement)
	(5)	Avg. annual operaing hours =	1177	(Operating logs)
	(6)	New motor premium efficiency =	96%	(Grainger No. 386)

$$\text{Max kW of existing motor} = \frac{440\ \text{V} \times 180\ \text{A} \times 1.73 \times 0.86}{0.92 \times 1000} = 128.2\ \text{kW}$$

$$\text{Percent operating load} = \frac{122.5\ \text{kW}}{128.2\ \text{kW}} = 95.5\%$$

$$\text{Operating kW of new motor} = \frac{150\ \text{hp} \times 0.955 \times 0.7457\ \text{kW/bhp}}{0.96} = 111.3\ \text{kW}$$

$$\text{Electric Demand Savings} = 122.5\ \text{kW} - 111.3\ \text{kW} = 11.2\ \text{kW}$$

$$\text{Electric Energy Savings} = 11.2\ \text{kW} \times 1177\ \text{Hr/Yr} = 13{,}139\ \text{kWh/Yr}$$

$$\text{Electric Energy Savings} = 13{,}139\ \text{kWh/Yr} \times 0.003413 \frac{\text{MBtu}}{\text{kWh}} = 44.8\ \text{MBtu/Yr}$$

E3-CALC1.XLS

ECO CALCULATIONS
Energy Efficient Motors

Project:	Raw Water Pump - Bldg. 42-020	RSH No.:	6941331004
Location:	Pine Bluff Arsenal, AR	Date:	6/20/96
ECO No.:	E3	Designer:	W. Todd

Assumptions:	(1)	Motor nameplate horsepower =	150	(Name plate data)
	(2)	Efficiency of existing motor =	94%	(C/S Engineer Article)
	(3)	Exist. motor electric data:	460 V	(Name plate data)
			179 A	"
			3 ph	"
			0.86 pf	(Estimated)
	(4)	Measured/estimated kW =	104.4	(Estimated, 80% of FL)
	(5)	Avg. annual operaing hours =	1177	(Operating logs)
	(6)	New motor premium efficiency =	96%	(Grainger No. 386)

$$\text{Max kW of existing motor} = \frac{460\ \text{V} \times 179\ \text{A} \times 1.73 \times 0.86}{0.94 \times 1000} = 130.5\ \text{kW}$$

$$\text{Percent operating load} = \frac{104.4\ \text{kW}}{130.5\ \text{kW}} = 80.0\%$$

$$\text{Operating kW of new motor} = \frac{150\ \text{hp} \times 0.800 \times 0.7457\ \text{kW/bhp}}{0.96} = 93.2\ \text{kW}$$

$$\text{Electric Demand Savings} = 104.4\ \text{kW} - 93.2\ \text{kW} = 11.2\ \text{kW}$$

$$\text{Electric Energy Savings} = 11.2\ \text{kW} \times 1177\ \text{Hr/Yr} = 13{,}186\ \text{kWh/Yr}$$

$$\text{Electric Energy Savings} = 13{,}186\ \text{kWh/Yr} \times 0.003413\ \frac{\text{MBtu}}{\text{kWh}} = 45.0\ \text{MBtu/Yr}$$

E3-CALC2.XLS

ECO CALCULATIONS
Energy Efficient Motors

Project:	Raw Water Pump - Bldg. 42-030	RSH No.:	6941331004
Location:	Pine Bluff Arsenal, AR	Date:	6/20/96
ECO No.:	E3	Designer:	W. Todd

Assumptions:	(1)	Motor nameplate horsepower =	150	(Name plate data)
	(2)	Efficiency of existing motor =	92%	(C/S Engineer Article)
	(3)	Exist. motor electric data:	440 V	(Name plate data)
			180 A	"
			3 ph	"
			0.86 pf	(Estimated)
	(4)	Measured/estimated kW =	89.5	(Field Measurement)
	(5)	Avg. annual operaing hours =	1177	(Operating logs)
	(6)	New motor premium efficiency =	96%	(Grainger No. 386)

$$\text{Max kW of existing motor} = \frac{440 \text{ V} \times 180 \text{ A} \times 1.73 \times 0.86}{0.92 \times 1000} = 128.2 \text{ kW}$$

$$\text{Percent operating load} = \frac{89.5 \text{ kW}}{128.2 \text{ kW}} = 69.8\%$$

$$\text{Operating kW of new motor} = \frac{150 \text{ hp} \times 0.698 \times 0.7457 \text{ kW/bhp}}{0.96} = 81.3 \text{ kW}$$

$$\text{Electric Demand Savings} = 89.5 \text{ kW} - 81.3 \text{ kW} = 8.2 \text{ kW}$$

$$\text{Electric Energy Savings} = 8.2 \text{ kW} \times 1177 \text{ Hr/Yr} = 9{,}607 \text{ kWh/Yr}$$

$$\text{Electric Energy Savings} = 9{,}607 \text{ kWh/Yr} \times 0.003413 \frac{\text{MBtu}}{\text{kWh}} = 32.8 \text{ MBtu/Yr}$$

E3-CALC3.XLS

Pine Bluff Arsenal - Electrical Demand and Heating Study
Buildings 42-010, 42-020 and 42-030; Raw (well) Water Pumps
Date: 6/20/96

ASSUMPTIONS:
(1) Operating schedule obtained from PBA staff, see attached.
(2) One pump operates and the other two are standby.

Mon-YR	Total Oper. Hrs/Day (1)	Available Hrs/Day (2)	Diversity (1) / (2)	Number Days/Month	Oper. Hrs/Mo (1) x Day/Mo
Jan-95	9.00	72	0.13	31	279
Feb-95	8.75	72	0.12	28	245
Mar-95	9.75	72	0.14	31	302
Apr-95	9.40	72	0.13	30	282
May-95	9.50	72	0.13	31	295
Jun-95	9.60	72	0.13	30	288
Jul-95	9.75	72	0.14	31	302
Aug-95	9.75	72	0.14	31	302
Sep-95	9.75	72	0.14	30	293
Oct-95	9.60	72	0.13	31	298
Nov-95	10.90	72	0.15	30	327
Dec-95	10.30	72	0.14	31	319

Total Operating Hours per Year = 3532

Average Annual Operating Hours per Pump Motor = 1177

MESSAGE DISPLAY FOR NANCY RIMMER

NANCY RIMMER
cc GREGORY BURRIS

From: GREGORY BURRIS Host: MVB
Postmark: Feb 05,96 12:47 PM Delivered: Feb 05,96 12:47 PM
Status: Certified Previously read
Subject: RAW WATER HOURS PER DAY FILTERED WATER HOURS PER.DAY

Message:

JAN.95	9.00 HRS.	26.30 HRS. PER TWO PUMPS
FEB.95	8.75	27.00
MAR.95	9.75	25.30
APR.95	9.40	25.30
MAY 95	9.50	24.50
JUN.95	9.60	25.75
JULY.95	9.75	25.00
AUG.95	9.75	24.00
SEPT.95	9.75	22.80
OCT.95	9.60	23.70
NOV.95	10.90	26.25
DEC.95	10.30	25.80

------========X=============-------

A.5.E3-9

By DARRYL J. VAN SON
Baldor
Fort Smith, Ark.

Last year, the World Watch Institute in Washington, D.C., released a study called "Building on Success: The Age of Energy Efficiency." It gives an overview of the long-term implications of energy use and waste. The authors say an environmentally sound energy strategy is a prerequisite to a sustainable society and that a prerequisite to any viable strategy is more efficient energy use.

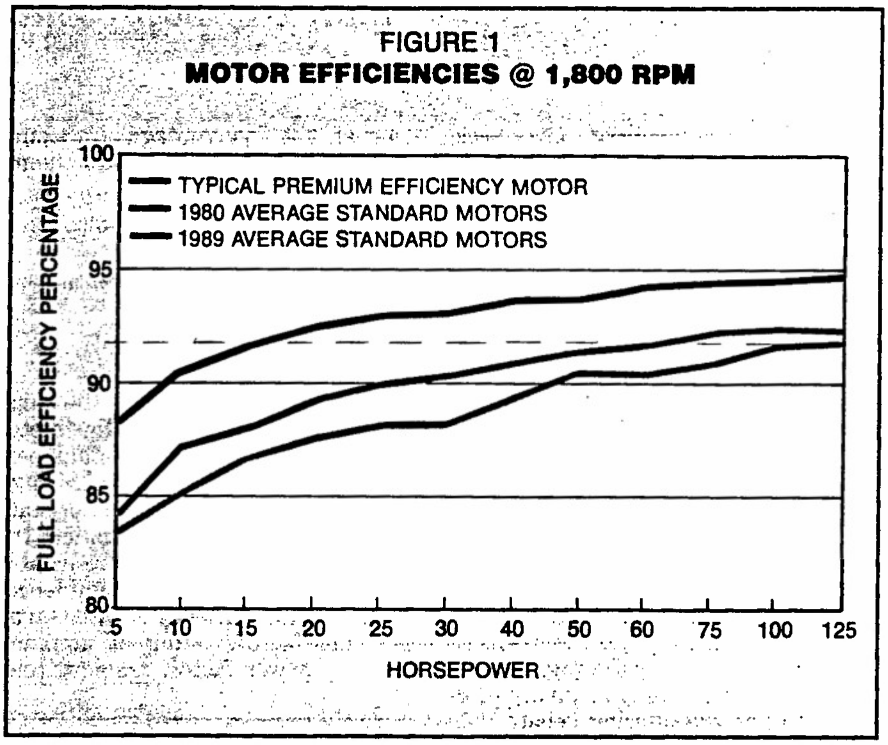
The good news in this report is how much we have accomplished collectively in the last 15 years. Since the Arab oil embargo of 1973, the world has saved far more energy through improved efficiency than it has gained from all new sources. The United States reduced energy intensity by more than 20%. From 1973 to 1987, our GNP went up 40% but total energy use grew by only 3%. This vast improvement has occurred largely without notice. The World Watch authors state, "We feel it is now possible in most industrialized countries to keep energy consumption level for the foreseeable future without sacrificing economic growth."

Part of the reason we did not notice these improvements was that there was no single sweeping technological breakthrough or new "wonder" source discovery. It was accomplished and will continue to be accomplished through a myriad of small incremental improvements in everything we design and build. The United States now spends 11.2% of its GNP on energy, but as much as 50% of this is wasted on inefficiencies of one form or another. There is much room for improvement in the future.

Between 50% and 60% of U.S. electricity is used to drive electric motors. Therefore, they are an obvious target for careful specifying. Of this electricity, more than 80% drives integral horsepower, polyphase motors. Although fractional horsepower motors represent the highest unit volume, they consume only 7% of the electricity used.

Motor efficiency

To look at reducing motor energy use, it is best to investigate two areas: the motor's efficiency and the operating system efficiency. In the last 10 years, virtually every motor manufacturer has introduced a line of premium-efficiency motors. This technology also filtered down to standard motors. In other words, the motor industry has continued to improve products across the board (see Figure 1).



Since the late 1970s, average efficiencies for standard motors have improved significantly.

The U.S. Department of Energy studied motor efficiency and published the "Classification and Evaluation of Electric Motors and Pumps" in February 1980. Comparing "Average Standard Motors" of the late 1970s to today's nonpremium motors shows that even "normal" motors have reduced wasted energy by more than 11% on average. For example, a 75-hp, four-pole motor in 1979 had a typical efficiency of 90.8%. In 1989, that same motor typically has a 92.1% efficiency. That same rating in a premium motor will, on average, be 94.3% efficient.

Between 50% and 60% of U.S. electricity is used to drive electric motors

Many manufacturers offer products with labels such as high efficiency, premium efficiency, super efficient and extra efficient. However, of greater importance is the actual efficiency on the nameplate. Domestic manufacturers have now standardized on IEEE 112B test methods, so direct comparison of nameplates is practical. Most motor manufacturers have some form of computerized savings and payback analysis. However, a quick approximation of annual savings can be calculated with this formula:

Annual Savings = Efficiency difference × kw × $/kwh × hrs/yr × 1.15

Where:

Efficiency difference = Motor A − Motor B (decimal, not percent)
kw = hp × .746
$/kwh = local power rate
hrs/yr = hours/day × days/year

Example: 75 hp, 94.3% efficiency vs. 90.8% efficiency, continuous duty at 6 cents per kwh: 0.035 × 55.95 × 0.06 × 8736 × 1.15 = $1,180 annual savings.

This boils down to greater savings. The more the motor is used, the higher the energy cost, the higher the horsepower or the greater the efficiency improvement.

As a rule-of-thumb, premium-efficiency motors are the best choice if power rates are more than 6 cents per kilowatt-hour and the motor is used two shifts per day or more.

The next logical step is payback analysis. This is a simple calculation of annual savings divided by the premium price differential greater than a standard motor. This yields the

A.5.E3-10

ELECTRIC MOTOR DATA SHEET

Survey Date: 1/31 & 3/27/96; Survey By: CSW / WT

Equipment ID/Function: Well Pump No. 1, Raw Water

Location: Bldg. 42-010

Nameplate Data:

Manufacturer: U.S. Electric Motor, LA Calif & Milford CT

Model No.: TYPE CFU, NRR; Serial No.: 1222685

Insulation Class: ____; NEMA Design: ____; Code: ____; Efficiency: ____

Horsepower 150; Frame 587P; RPM ____; Service Factor ____

Volts 440; Amps 180; Phases 3; Hz 60; PF ____; kW ____

Type: Synchronous ____; Induction ✓; Other ____

For Synchronous Motors: DC Excitation Volts ____; Amps ____

Electrical Measurements: CSW WTT

Measurements	Phase 1	Phase 2	Phase 3	Phase	Phase A-B	Phase B-C
Volts(rms)	4.824	4.907	4.999		496.6	492.3
Amps(rms)	177.9	171.4	169.4		171.7	165.2
kW	0.456	0.430	0.414		41.[illegible]	81.26
kVAR	0.722 LA	0.722 LA	0.739 LA		74.36 LA	1.04 LA
kVA	0.856	0.843	0.850		85.02	81.28
Power Factor	0.53	0.51	0.48		0.48	0.99
dPF	"	"	"		"	"
kdVA	60.62	51.88	53.25		1.173	1.552

General Condition/Comments: HAS BEEN REWOUND / REFURBISHED

ELECTRIC MOTOR DATA SHEET

Survey Date: 3/27/96; Survey By: WTT

Equipment ID/Function: Well Pump No. 2 / Raw Water

Location: Next to Bldg. 42-210

Nameplate Data:

Manufacturer: US Electric Motors

~~Model~~ ID No.: 6350 / X09X125R644R-4; Serial No.: _____

Insulation Class: B; NEMA Design: ____; Code: ____; Efficiency: ____

Horsepower 150; Frame 444 TP; RPM 1775; Service Factor 1.15

Volts 460; Amps 179; Phases 3; Hz ____; PF ____; kW ____

Type: Synchronous ____; Induction ✓; Other Continuous

For Synchronous Motors: DC Excitation Volts ____; Amps ____

Electrical Measurements:

Measurements	Phase	Phase	Phase	Phase	Phase	Phase
Volts(rms)						
Amps(rms)						
kW						
kVAR						
kVA						
Power Factor						
dPF						
kdVA						

General Condition/Comments: Not operating during survey - Pump and motor are new, electric not yet connected.

ELECTRIC MOTOR DATA SHEET

Survey Date: 1/31/96; Survey By: CSW

Equipment ID/Function: Well Pump No. 3, Raw Water

Location: Bldg. 42-030

Nameplate Data:

Manufacturer: ______

Model No.: ______; Serial No.: ______

Insulation Class: ____; NEMA Design: ____; Code: ____; Efficiency: ____

Horsepower 150; Frame 587 P; RPM 1800; Service Factor ____

Volts 440; Amps 180; Phases 3; Hz 60; PF ____; kW ____

Type: Synchronous ____; Induction ✓; Other ______

For Synchronous Motors: DC Excitation Volts ____; Amps ____

Electrical Measurements:

Measurements	Phase 1	Phase 2	Phase 3	Phase	Phase	Phase
Volts(rms)	201.8	204.8	209.9			
Amps(rms)	175.9	170.9	179.2			
kW	29.88	28.58	31.00			
kVAR (LAG)	19.06	20.27	21.35			
kVA	35.45	35.05	37.65			
Power Factor	0.84	0.81	0.82			
dPF	"	"	"			
kdVA	0.594	0.610	0.714			

General Condition/Comments: ______

A.5.E3-13

ECO-E4

Replace the filtered water pump motors in Building 42-210 with energy efficient motors.

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-E4
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: P B ARSENAL REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: ECO-E4 EFFICIENT MOTORS FOR FILTERED WTR PUMPS
FISCAL YEAR 1997 DISCRETE PORTION NAME: COMPLETE PROJECT
ANALYSIS DATE: 07-01-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

A. CONSTRUCTION COST	$ 7429.		
B. SIOH	$ 446.		
C. DESIGN COST	$ 446.		
D. TOTAL COST (1A+1B+1C)	$ 8321.		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F. PUBLIC UTILITY COMPANY REBATE		$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 8321.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 16.79	69.	$ 1155.	15.08	$ 17420.
B. DIST	$ .00	0.	$ 0.	18.57	$ 0.
C. RESID	$ .00	0.	$ 0.	21.02	$ 0.
D. NAT G	$ 2.81	0.	$ 0.	18.58	$ 0.
E. COAL	$ .00	0.	$ 0.	16.83	$ 0.
F. PPG	$ .00	0.	$ 0.	17.38	$ 0.
M. DEMAND SAVINGS			$ 0.	14.88	$ 0.
N. TOTAL		69.	$ 1155.		$ 17420.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)		$ 0.
(1) DISCOUNT FACTOR (TABLE A)	14.88	
(2) DISCOUNTED SAVING/COST (3A X 3A1)		$ 0.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 0.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 1155.

5. SIMPLE PAYBACK PERIOD (1G/4) 7.20 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 17420.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 2.09
(IF < 1 PROJECT DOES NOT QUALIFY)

A.5,E4-2

RS&H	SUBJECT PBA ELEC +HTG STUDY EFF. FILTERED WTR PUMP MOTORS	AEP NO 694-1331-004	
	DESIGNER W. TODD	SHEET ______ OF ______	
		DATE 6-20-96	
	CHECKER ______	DATE ______	

ECO-E4 ENERGY EFFICIENT MOTORS FOR FILTERED WATER PUMPS

There are 4 filtered water pump in Bldg. 42-210. They are used to pump treated water from the water plant up to the water towers. Two of the pumps are used at one time and they are all alternated into service on a daily schedule: day 1 - pumps 1+2, day 2 - pumps 1 and 3, day 3 - pumps 1 and 4, day 4 pumps 2 and 3, etc.

Actual operating hours were obtained from the water plant staff. See attached message from G. Burris, and calculation of annual operating hours.

The motor operating kw was measured and the average kw was used in the energy savings calculations. See attached Electric Motor Data Sheets.

$$\text{AVG kW} = (26.4 + 22.1 + 23.6 + 22.4)\,\text{kw} \div 4 = 23.6 \text{ kW}$$

The existing motors are very old; the efficiency was estimated based on a C/S Engineer article (see attached) to be ~ 88%

Energy savings for one motor was calculated by the attached spreadsheet.

$$\text{Total Energy Savings} = 17.2 \times 4 = \underline{68.8 \ \text{MBtu/YR}}$$

CONSTRUCTION COST ESTIMATE

Project:	Energy Efficient Motors - Filtered Water Pumps	RS&H No.:	694-1331-004
Location:	Pine Bluff Arsenal, AR	Date:	6/21/96
Basis:	Schematic Design	Estimator:	W. Todd
ECO Number:	E4	Filename:	EST-E4.XLS

ITEM DESCRIPTION	QUANTITY		MATERIAL/EQUIP		LABOR		TOTAL COST	SOURCE	
	No.	Unit	$/Unit	Total	$/Unit	Total		Material	Labor
Remove 30 HP Motors	0.86	Ton		0	395	340	340		MMp21
30 HP Premium Eff. Motor	4	Ea	997	3,988	97.5	390	4,378	GRp27	MEp199
Restricted Area Handling	4	Ea		0	390	1,560	1,560		MEp199
Overload Thermal Units	12	Ea	9	108	4.88	59	167	SDp23-18	Note (1)
Subtotal Bare Costs				4,096		2,349	6,445		
Retrofit Cost Factors			0%	0	0%	0	0	MMp6	MMp6
Subtotal				4,096		2,349	6,445		
City Cost Index			0.952	(197)	0.632	(864)	(1,061)	MMp533	MMp533
Subtotal				3,899		1,485	5,384		
OH & Profit Markups			10%	390	53%	787	1,177	MMp7	MMp475
Subtotal				4,289		2,272	6,561		
State Sales Taxes			4.5%	193		N.A.	193	MMp476	
Subtotal				4,482		2,272	6,754		
Contingency			10%	448	10%	227	675	MEp6	MEp6
Total Construction Cost				**4,930**		**2,499**	**$7,429**		
Design Fee				N.A.	6.0%	446	446		
SIOH				N.A.	6.0%	446	446		
Total Project Cost				**4,930**		**3,391**	**$8,321**		

LEGEND:

Note (1)	Assumes 10 minutes to install each thermal unit.
GRp###	Grainger General catalog Number 386, page ###.
MEp###	1996 Means Electrical Cost Data, page ###.
MMp###	1996 Means Mechanical Cost Data, page ###.
SDp###	Square-D Digest Number 170, page ###.

ECO CALCULATIONS
Energy Efficient Motors

Project:	Filtered Water Pumps - Bldg. 42-210	RSH No.:	6941331004
Location:	Pine Bluff Arsenal, AR	Date:	6/20/96
ECO No.:	E4	Designer:	W. Todd

Assumptions:	(1)	Motor nameplate horsepower =	30	(Name plate data)
	(2)	Efficiency of existing motor =	88%	(C/S Engineer Article)
	(3)	Exist. motor electric data:	440 V	(Name plate data)
			36 A	"
			3 ph	"
			0.84 pf	(Estimated)
	(4)	Measured/estimated kW =	23.6	(Avg. of measurements)
	(5)	Avg. annual operaing hours =	2293	(Operating logs)
	(6)	New motor premium efficiency =	94%	(Grainger No. 386)

$$\text{Max kW of existing motor} = \frac{440\ \text{V} \times 36\ \text{A} \times 1.73 \times 0.84}{0.88 \times 1000} = 26.2\ \text{kW}$$

$$\text{Percent operating load} = \frac{23.6\ \text{kW}}{26.2\ \text{kW}} = 90.1\%$$

$$\text{Operating kW of new motor} = \frac{30\ \text{hp} \times 0.901 \times 0.7457\ \text{kW/bhp}}{0.94} = 21.4\ \text{kW}$$

$$\text{Electric Demand Savings} = 23.6\ \text{kW} - 21.4\ \text{kW} = 2.2\ \text{kW}$$

$$\text{Electric Energy Savings} = 2.2\ \text{kW} \times 2293\ \text{Hr/Yr} = 5{,}045\ \text{kWh/Yr}$$

$$\text{Electric Energy Savings} = 5{,}045\ \text{kWh/Yr} \times 0.003413\ \frac{\text{MBtu}}{\text{kWh}} = 17.2\ \text{MBtu/Yr}$$

Pine Bluff Arsenal - Electrical Demand and Heating Study
Building 42-210, Filtered Water Pumps
Date: 6/20/96

ASSUMPTIONS:
1) Operating schedule obtained from PBA staff, see attached.
2) Two pumps operate and the other two are standby.

Mon-YR	Total Op. Hr/Da (1)	Available Hr/Da (2)	Diversity (1) / (2)	Number Days/Mo	Total Hrs/Mo (1) x Day/Mo
Jan-95	26.3	96	0.27	31	815
Feb-95	27.0	96	0.28	28	756
Mar-95	25.3	96	0.26	31	784
Apr-95	25.3	96	0.26	30	759
May-95	24.5	96	0.26	31	760
Jun-95	25.8	96	0.27	30	773
Jul-95	25.0	96	0.26	31	775
Aug-95	24.0	96	0.25	31	744
Sep-95	22.8	96	0.24	30	684
Oct-95	23.7	96	0.25	31	735
Nov-95	26.3	96	0.27	30	788
Dec-95	25.8	96	0.27	31	800

Total annual operating hours = 9172

Average annual operating hours per pump motor = 2293

MESSAGE DISPLAY FOR NANCY RIMMER

NANCY RIMMER
CC GREGORY BURRIS

From: GREGORY BURRIS Host: MVB
Postmark: Feb 05,96 12:47 PM Delivered: Feb 05,96 12:47 PM
Status: Certified Previously read
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NOV.95	10.90	26.25	
DEC.95	10.30	25.80	

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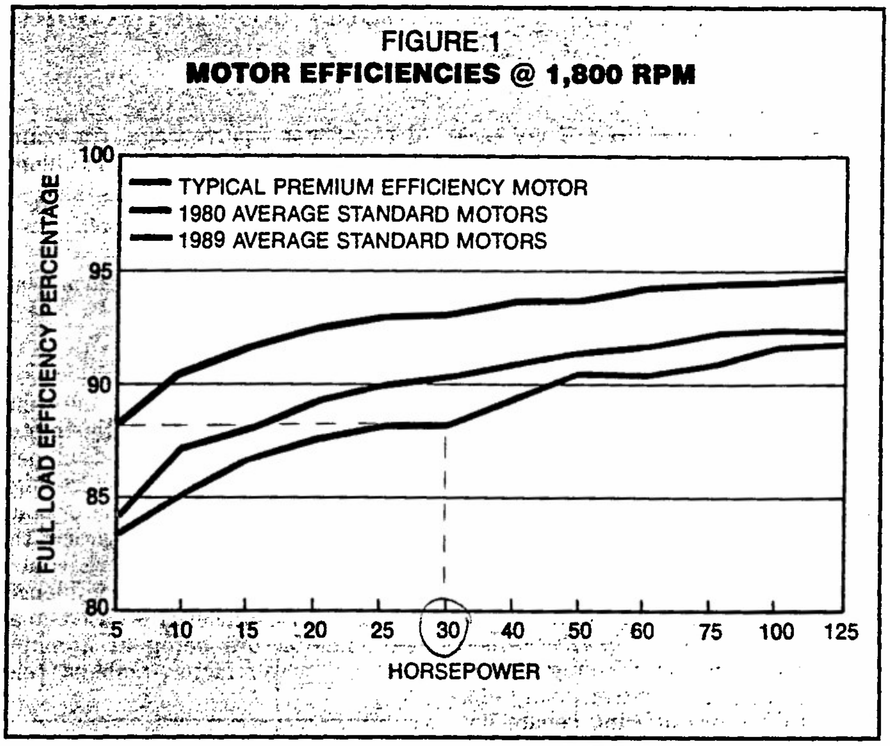
A.5.E4-7

By DARRYL J. VAN SON
Baldor
Fort Smith, Ark.



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Annual Savings = Efficiency difference × kw × \$/kwh × hrs/yr × 1.15

Where:

Efficiency difference = Motor A − Motor B (decimal, not percent)
kw = hp × .746
\$/kwh = local power rate
hrs/yr = hours/day × days/year

Example: 75 hp, 94.3% efficiency vs. 90.8% efficiency, continuous duty at 6 cents per kwh: 0.035 × 55.95 × 0.06 × 8736 × 1.15 = \$1,180 annual savings.

This boils down to greater savings. The more the motor is used, the higher the energy cost, the higher the horsepower or the greater the efficiency improvement.

As a rule-of-thumb, premium-efficiency motors are the best choice if power rates are more than 6 cents per kilowatt-hour and the motor is used two shifts per day or more.

The next logical step is payback analysis. This is a simple calculation of annual savings divided by the premium price differential greater than a standard motor. This yields the

A.5.E4-8

ELECTRIC MOTOR DATA SHEET

Survey Date: 1/31 & 3/27/96; Survey By: CSW / WTT

Equipment ID/Function: Filtered Watered Pump No. 1

Location: Building 42-210

Nameplate Data:

Manufacturer: Sterling Motor

Model No.: TYPE KF; Serial No.: 145090

Insulation Class: ____; NEMA Design: ____; Code: ____; Efficiency: _____

Horsepower 30; Frame 405; RPM 1800; Service Factor _____

Volts 220/440; Amps 72/36; Phases 3; Hz 60; PF _____; kW _____

Type: Synchronous _____; Induction ✓; Other 40°C Rating

For Synchronous Motors: DC Excitation Volts _____; Amps _____

Electrical Measurements:

Measurements	Phase	Phase	Phase	~~Phase~~ TOTAL	Phase	Phase
Volts(rms)	281.7	277.3	283.2			
Amps(rms)	36.37	34.05	35.5			
kW	9.217	8.399	8.781	26.4		
kVAR	LA 4.501	LA 4.247	LA 4.926			
kVA	10.25	9.413	10.07			
Power Factor	0.89	0.89	0.87			
dPF	"	"	"			
kdVA	174.7	137.6	158.9			

General Condition/Comments: ______

ELECTRIC MOTOR DATA SHEET

Survey Date: 1/31/96; Survey By: CSW

Equipment ID/Function: Filtered Water Pump No. 2

Location: Bldg. 42-210

Nameplate Data: Not Legible

Manufacturer: ____

Model No.: ____; Serial No.: ____

Insulation Class: ____; NEMA Design: ____; Code: ____; Efficiency: ____

Horsepower 30; Frame ____; RPM ____; Service Factor ____

Volts ____; Amps ____; Phases ____; Hz ____; PF ____; kW ____

Type: Synchronous ____; Induction ____; Other ____

For Synchronous Motors: DC Excitation Volts ____; Amps ____

Electrical Measurements:

Measurements	Phase	Phase	Phase	~~Phase~~ TOTAL	Phase	Phase
Volts(rms)	282.0	278.0	284.9			
Amps(rms)	31.37	29.54	30.55			
kW	7.673	7.109	7.343	22.1		
kVAR	4.415 LAG	4.091 LAG	4.092 LAG			
kVA	8.854	8.204	8.716			
Power Factor	0,86	0.86	0.84			
dPF	"	"	"			
kdVA	152.2	138.7	146.9			

General Condition/Comments: ____

ELECTRIC MOTOR DATA SHEET

Survey Date: 1/31/96; Survey By: CSW

Equipment ID/Function: Filtered Water Pump No. 3

Location: Bldg. 42-210

Nameplate Data: Not Legible

Manufacturer: ______

Model No.: ______; Serial No.: ______

Insulation Class: ____; NEMA Design: ____; Code: ____; Efficiency: ____

Horsepower 30; Frame ______; RPM ____; Service Factor ____

Volts 220/440; Amps ______; Phases 3; Hz ____; PF ____; kW ____

Type: Synchronous ____; Induction ____; Other ______

For Synchronous Motors: DC Excitation Volts ____; Amps ____

Electrical Measurements:

Measurements	Phase	Phase	Phase	~~Phase~~ TOTAL	Phase	Phase
Volts(rms)	282.2	278.4	284.7			
Amps(rms)	34.22	31.29	32.83			
kW	8.350	7.495	7.715	23.6		
kVAR	4.874 LAG	4.452 LAG	5.323 LAG			
kVA	9.670	8.719	9.375			
Power Factor	0.86	0.85	0.82			
dPF	"	"	"			
kdVA	183.3	154.8	136.1			

General Condition/Comments: Pump Data: 700 GPM, 130 Ft HD Gardner-Denver, Cent. Pump, Quincy, Ill. Size 5, TYPE F, SN 261495, 1750 RPM

A.5.E4-11

ELECTRIC MOTOR DATA SHEET

Survey Date: 1/31/96; Survey By: CSW

Equipment ID/Function: Filtered Water Pump No. 4

Location: Bldg. 42-210

Nameplate Data: Not Legible

Manufacturer: ______

Model No.: ______; Serial No.: ______

Insulation Class: ____; NEMA Design: ____; Code: ____; Efficiency: ____

Horsepower ____; Frame ____; RPM ____; Service Factor ____

Volts ____; Amps ____; Phases ___; Hz ____; PF ____; kW ____

Type: Synchronous ____; Induction ____; Other ______

For Synchronous Motors: DC Excitation Volts ____; Amps ____

Electrical Measurements:

Measurements	Phase	Phase	Phase	~~Phase~~ TOTAL	Phase	Phase
Volts(rms)	281.9	277.4	283.1			
Amps(rms)	32.73	29.67	31.06			
kW	8.015	7.110	7.301	22.4		
kVAR	4.577 LAG	4.192 LAG	4.898 LAG			
kVA	9.232	8.255	8.793			
Power Factor	0.86	0.86	0.83			
dPF	"	"	"			
kdVA	187.5	142.4	153.4			

General Condition/Comments: ______

A.5. E4-12

ECO-E5

Replace the afterburner scrubber fan motor in the incinerator area with an energy efficient motor.

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: ECO-E5
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID FY95 (92)
INSTALLATION & LOCATION: P B ARSENAL REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: ECO-E5 EFFICIENT MOTOR FOR INCINERATOR SCRUBBER
FISCAL YEAR 1997 DISCRETE PORTION NAME: COMPLETE PROJECT
ANALYSIS DATE: 07-01-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

A. CONSTRUCTION COST	$ 18956.		
B. SIOH	$ 1138.		
C. DESIGN COST	$ 1138.		
D. TOTAL COST (1A+1B+1C)	$ 21232.		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F. PUBLIC UTILITY COMPANY REBATE		$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 21232.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 16.79	131.	$ 2199.	15.08	$ 33168.
B. DIST	$ .00	0.	$ 0.	18.57	$ 0.
C. RESID	$ .00	0.	$ 0.	21.02	$ 0.
D. NAT G	$ 2.81	0.	$ 0.	18.58	$ 0.
E. COAL	$ .00	0.	$ 0.	16.83	$ 0.
F. PPG	$ .00	0.	$ 0.	17.38	$ 0.
M. DEMAND SAVINGS			$ 0.	14.88	$ 0.
N. TOTAL		131.	$ 2199.		$ 33168.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ 0.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 2199.

5. SIMPLE PAYBACK PERIOD (1G/4) 9.65 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 33168.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 1.56
(IF < 1 PROJECT DOES NOT QUALIFY)

A.5.E5-2

ECO CALCULATIONS
Energy Efficient Motors

Project:	Incinerator Scrubber Fan	RSH No.:	6941331004
Location:	Pine Bluff Arsenal, AR	Date:	6/26/96
ECO No.:	E5	Designer:	W. Todd

Assumptions:	(1)	Motor nameplate horsepower =	350	(Name plate data)
	(2)	Efficiency of existing motor =	95%	(Grainger No. 386, p15)
	(3)	Exist. motor electric data:	460 V	(Name plate data)
			382 A	(Name plate data)
			3 ph	(Name plate data)
			0.88 pf	(Estimated)
	(4)	Measured/estimated kW =	131.3	(Field Measurement)
	(5)	Avg. annual operaing hours =	8344	(Operating Staff)
	(6)	New motor premium efficiency =	96%	(Grainger No. 386, p27)

$$\text{Max kW of existing motor} = \frac{460 \text{ V} \times 382 \text{ A} \times 1.732 \times 0.88}{0.95 \times 1000} = 281.9 \text{ kW}$$

$$\text{Percent operating load} = \frac{131.3 \text{ kW}}{281.9 \text{ kW}} = 46.6\%$$

$$\text{Operating kW of new motor} = \frac{350 \text{ hp} \times 0.466 \times 0.7457 \text{ kW/bhp}}{0.96} = 126.7 \text{ kW}$$

$$\text{Electric Demand Savings} = 131.3 \text{ kW} - 126.7 \text{ kW} = 4.6 \text{ kW}$$

$$\text{Electric Energy Savings} = 4.6 \text{ kW} \times 8344 \text{ Hr/Yr} = 38{,}382 \text{ kWh/Yr}$$

$$\text{Electric Energy Savings} = 38{,}382 \text{ kWh/Yr} \times 0.003413 \frac{\text{MBtu}}{\text{kWh}} = 131.0 \text{ MBtu/Yr}$$

E5-CALC1.XLS

CONSTRUCTION COST ESTIMATE

Project:	Energy Efficient Motors - Afterburner Scrubber Fan	RS&H No.:	694-1331-004
Location:	Pine Bluff Arsenal, AR	Date:	6/21/96
Basis:	Schematic Design	Estimator:	W. Todd
ECO Number:	E5	Filename:	EST-E5.XLS

ITEM DESCRIPTION	QUANTITY		MATERIAL/EQUIP		LABOR		TOTAL	SOURCE	
	No.	Unit	$/Unit	Total	$/Unit	Total	COST	Material	Labor
Remove 350 HP Motor	1.25	Ton		0	395	492	492		MMp21
350 HP premium eff. motor (1)	1	Ea	14572.5	14,573	790	790	15,363	GRp15	MEp199
Overload Thermal Units	3	Ea	9	27	4.88	15	42	SDp23-18	Note (2)
Subtotal Bare Costs				14,600		1,297	15,897		
Retrofit Cost Factors			0%	0	0%	0	0	MMp6	MMp6
Subtotal				14,600		1,297	15,897		
City Cost Index			0.952	(701)	0.632	(477)	(1,178)	MMp533	MMp533
Subtotal				13,899		820	14,719		
OH & Profit Markups			10%	1,390	53%	435	1,825	MMp7	MMp475
Subtotal				15,289		1,255	16,544		
State Sales Taxes			4.5%	688		N.A.	688	MMp476	
Subtotal				15,977		1,255	17,232		
Contingency			10%	1,598	10%	126	1,724	MEp6	MEp6
Total Construction Cost				**17,575**		**1,381**	**$18,956**		
Design Fee				N.A.	6.0%	1,137	1,137		
SIOH				N.A.	6.0%	1,137	1,137		
Total Project Cost				**17,575**		**3,655**	**$21,230**		

LEGEND:

Note (1)	Material cost for std motor x 1.25 for premium efficiency, labor cost extrapoleted from Means cost.
Note (2)	Assumes 10 minutes to install each thermal unit.
GRp###	Grainger General Catalog Number 386, page ###.
MEp###	1996 Means Electrical Cost Data, page ###.
MMp###	1996 Means Mechanical Cost Data, page ###.
SDp###	Square-D Digest Number 170, page ###.

RS&H
Reynolds, Smith and Hills, Inc.
Architectural, Engineering, Planning and Environmental Services

Telephone Call Confirmation

Date:	June 19, 1996
Project Number:	694-1331-004
Project Name:	Pine Bluff Arsenal Heating and Electric Study

Received:		**Placed:**	by W. Todd
Local:		**Long Dist.:**	501-540-3035
Conversed with:	C.D. Huggins		
of	PBA DMMD		

Regarding: Incinerator area scrubber fan operation.

The existing scrubber fan motor is fairly new - it was replaced less than one year ago. The cost to replace the motor was about $12,500, which included some overtime and next day shipping charges.

The scrubber system operates all the time (8760 hours/year) except when the system is shut down for maintenance - one shift for about 8 hours each week (416 hours/year).

The entire scrubber is scheduled to be replaced in about one year. The new system will be capable of processing at a higher flow rate and the pressure drop will also be significantly larger. The new system, which has already been purchased from Anderson 2000, will utilize two fans and two 400 horsepower electric motors. He did not know if energy efficient motors were specified for the new system. The new fan motors are scheduled to be controlled by variable frequency drives, however, C.D. does not like the idea and may not include it in the base contract. The VFD's will cost about $175/HP.

Distribution: C. Warren
File

By William T. Todd, PE

A.5.E5-5

ELECTRIC MOTOR DATA SHEET

Survey Date: 1/30 & 3/27/96; Survey By: CSW /WTT

Equipment ID/Function: B-462 / Central Afterburner & Scrubber Blower

Location: Outside Bldg. 42 979

Nameplate Data:

Manufacturer: TECO, Taiwan

Model No.: TYPE HD mill + Chem. Duty Serial No.: FF C56611-1 5009C

Insulation Class: F; NEMA Design: C; Code: G; Efficiency: ____

Horsepower 350; Frame ________; RPM 1785; Service Factor 1.15

Volts 460; Amps 382; Phases 4; Hz 60; PF ____; kW [illegible]

Type: Synchronous ____; Induction ✓; Other Continous, TEFC

For Synchronous Motors: DC Excitation Volts ____; Amps ____

Electrical Measurements:

Measurements	Phase	Phase	Phase	Phase	Phase	Phase
Volts(rms)	278.2	280.8	276.4	281.3	278.5	280.6
Amps(rms)	99.9	116.9	95.3	102.1	117.4	93.4
kW	11.62	17.44	15.32	28.59	32.34	26.00
kVAR	25.23 LA	27.71 LA	21.25 LA	3.10 LA	1.22 LE	2.67 LE
kVA	27.83	32.80	26.23	28.83	32.44	26.19
Power Factor	0.41	0.53	0.58	0.99	0.99	0.99
dPF	"	"	"	"	"	"
kdVA	1.566	1.967	1.294	1.983	2.157	1.651

General Condition/Comments: Wt = 1620 lbs, Y-Δ start

ECO CALCULATIONS
Compressor Energy Efficiency

Project:	Utilize Surplus Air Compressors	RSH No.:	6941331004
Location:	Pine Bluff Arsenal, AR	Date:	6/25/96
ECO No.:	C1	Designer:	W. Todd

Compressor Mfg.: Ingersoll-Rand Model: XLE

Assumptions:	(1)	Compressor air supply rate =		825 cfm	(Name plate data)
	(2)	Motor data:	Horsepower:	173	(Name plate data)
			Efficiency:	90%	(Est., Marks' p. 15-49)
			Volts:	460	(Name plate data)
			Amps:	206	(Name plate data)
			Phases:	3	(Name plate data)
			Power Factor:	0.80	(Est., Marks' p. 15-49)

$$\text{Maximum motor kW} = \frac{460 \text{ V} \times 206 \text{ A} \times 1.73 \times 0.8}{0.90 \times 1000} = 145.9 \text{ kW}$$

$$\text{Full Load Compressor Efficiency} = \frac{145.9 \text{ kW}}{825 \text{ cfm}} = 0.177 \text{ kW / cfm}$$

C1-CALC.XLS

ECO CALCULATIONS
Compressor Energy Efficiency

Project:	Utilize Surplus Air Compressors	RSH No.:	6941331004
Location:	Pine Bluff Arsenal, AR	Date:	6/25/96
ECO No.:	C1	Designer:	W. Todd

Compressor Mfg: Gardner Denver Model: MCY-MH

Assumptions:	(1)	Compressor air supply rate =		600 cfm	(Mfg. submittal data)
	(2)	Motor data:	Horsepower:	150	(Mfg. submittal data)
			Efficiency:	96.2%	(Granger Cat. No. 386)
			Volts:	460	(Mfg. submittal data)
			Amps:	168	(Mfg. submittal data)
			Phases:	3	(Mfg. submittal data)
			Power Factor:	0.85	(C/S Engineer Article)

$$\text{Maximum motor kW} = \frac{460 \text{ V} \times 168 \text{ A} \times 1.73 \times 0.85}{0.96 \times 1000} = 118.3 \text{ kW}$$

$$\text{Full Load Compressor Efficiency} = \frac{118.3 \text{ kW}}{600 \text{ cfm}} = 0.197 \text{ kW / cfm}$$

C1-CALC1.XLS

A.5.E5-8

ELECTRIC MOTOR DATA SHEET

Survey Date: 3/27 & 1/30/96; Survey By: WTT / CSW

Equipment ID/Function: Compressor No. 4

Location: Bldg. 34 140

Nameplate Data:

Manufacturer: General Electric

Model No.: 5SR 684 A60; Serial No.: DE 837 1527

Insulation Class: ____; NEMA Design: ____; Code: A; Efficiency: ____

Horsepower 173; Frame 965Y; RPM 600; Service Factor ____

Volts 460; Amps 206; Phases 3; Hz 60; PF 0.8; kW ____

Type: Synchronous ✓; Induction ____; Other TYPE TS

For Synchronous Motors: DC Excitation Volts 125; Amps 33

Electrical Measurements: ← CSW → | ← WTT →

Measurements	Phase 1	Phase 2	Phase 3	Phase	Phase 1-2	Phase 2-3
Volts(rms)	478.6	4.15	483.1		511.1	502.6
Amps(rms)	176.6	191.0	195.1		168.8	185.5
kW	86.12	-0.38	51.58		89.95	36.61
kVAR	1.77 LE	0.65 LA	80.07 LE		2.73 LE	80.29 LE
kVA	86.16	0.76	95.27		90.02	88.27
Power Factor	0.99	-0.5	0.54		0.99	0.41
dPF	0.99	-0.5	0.54		0.99	0.41
kdVA	2.010	44.43	1.995		2.092	2.103

General Condition/Comments: Motor Control Panel Readings:
169 Amps AC ; 34.5 Amps DC

AIR COMPRESSOR DATA

Survey by: GWF / WTT Date: 3/27/96
Maintenance Name: Phone:
Building Number: 34-140 Compressor I.D. No.: 3
Service area or Loads:

Compressor Specifications:
Mfg. & Model #: IR, TYPE XLE, MODEL 16-10×7
Type: Recip.: ✓ Cent.: Other: Date = 1967 SN JH4199
Capacity (cfm): 825 Operating Pressure (psig): 130
Electric Motor:
Type: Synchronous ✓ Induction: Other:
Volts: 460 Amps: 192 Phases: 3 Hz: 60 RPM: 600
HP: 150 Mfg: GE Model No.: 5SR 684 A52

Operation Schedule: hr/da: 24 da/wk: 7 mn/yr: 12
Cooling Method: Air: Water: ✓
Air Source Location: Outdoors: ✓ Other:
Control System: Pneumatic staging control - 2 stages
Manual on/off control.

Maintenance Schedule: As required, no PM

O&M log available: Yes No Copies Obtained: Yes No

Auxiliary Equipment: (Air Dryer, Heat Recovery, etc.)
Air dryer disconnected

Heat Recovery Potential: (Accessibility, heat load nearby) Use cooling water to preheat boiler feedwater? ~25°F ΔT

General Condition/Comments/Problems: GE 150 HP, PF = 0.8, 153 KVA
440 V, 201 A, 600 RPM

EXI, V = 125 A = 34.6
ARM AMPS = 216 AT SF = 1.15

MODEL 5SR 684 A52
SN BC 8370155

PANEL AC AMPS = 128
DC AMPS - NOT WORKING

A.5.E5-10

AIR COMPRESSOR DATA

Survey by: GWF / WTT Date: 3/27/96

Maintenance Name: Phone:

Building Number: 34-140 Compressor I.D. No.: 4

Service area or Loads: Area 3 Section 4 and Sections 1, 2 and 3 via header piping system.

Compressor Specifications:

Mfg. & Model #: INGERSOLL-RAND, TYPE XLE, MODEL 16-10x7

Type: Recip.: ✓ Cent.: Other: Date = 1967 SN: JH4868

Capacity (cfm): 825 Operating Pressure (psig): 130

Electric Motor:

Type: Synchronous ✓ Induction: Other:

Volts: 460 Amps: 206 Phases: 3 Hz: 60 RPM: 600

HP: 173 Mfg: GE Model No.: 5SR684A60

Operation Schedule: hr/da: 24 da/wk: 7 mn/yr: 12

Cooling Method: Air: Water: ✓

Air Source Location: Outdoors: ✓ Other:

Control System: Pneumatic staging control - 2 stages
Manual on/off control.

Maintenance Schedule: as required, no PM

O&M log available: Yes No Copies Obtained: Yes No

Auxiliary Equipment: (Air Dryer, Heat Recovery, etc.)
Air dryer disconnected.

Heat Recovery Potential: (Accessibility, heat load nearby) Use cooling water to preheat boiler feed water? ~25°ΔT

General Condition/Comments/Problems: PANEL { AC Amps = 169
DC AMPS = 34.5 }

A.5.E5-11

ıe by regulating the
. Long 220-kV lines
· line require several
loating at their load
becomes small, the
ıe synchronous con-
taining nearly con-

:arted as an induc-
ucting bars of cop-
amortisseur windings
:uited at the ends,
ınduction motor is
r starting purposes
speed and have no
ı block of steel is
-carrying function
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ıches 95 to 98 per-
field is applied by
ıe motor pulls into
ıg otor field
ıc ages and

round-rotor motors
thermal capacity
be started by sup-

· the use of a var-
generator or more
or is brought up
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ıan full voltage

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› produce high
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nnected to a dc
ously.
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ren Telechron
ple. The stator
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ng being
: rotor consists
ıown, mounted
ı 3,600 r/min
e of hysteresis

Table 15.1.14 Performance Data for Coupled Synchronous Motors

hp	Poles	r/min	A	Excitation, kW	Efficiencies, percent ½ load	¾ load	Full load	Weight, lb
Unity power factor, 3 phase, 60 Hz, 2,300 V								
500	4	1,800	100	3	94.5	95.2	95.3	5,000
2,000	4	1,800	385	9	96.5	97.1	97.2	15,000
5,000	4	1,800	960	13	96.5	97.3	97.5	27,000
10,000	6	1,200	1,912	40	97.5	97.9	98.0	45,000
500	18	400	99.3	5	92.9	93.9	94.3	7,150
1,000	24	300	197	8.4	93.7	94.6	95.0	15,650
4,000	48	150	781	25	94.9	95.6	95.6	54,000
80% power factor, 3 phase, 60 Hz, 2,300 V								
500	4	1,800	127	4.5	93.3	94.0	94.1	6,500
2,000	4	1,800	486	13	95.5	96.1	96.2	24,000
5,000	4	1,800	1,212	21	95.5	96.3	96.5	37,000
10,000	6	1,200	2,405	50	96.8	97.3	97.4	70,000
500	18	400	125	7.2	92.4	93.4	93.6	9,500
1,000	24	300	248	11.6	93.3	94.2	94.4	17,500
4,000	48	150	982	40	94.6	95.3	95.5	11,500

SOURCE: Westinghouse Electric Corp.

loss, the disk follows the field just as the rotor of an induction motor does. When the rotor approaches the synchronous speed of 3,600 r/min, the rotating magnetic field takes a path along the two rotor bars and locks the rotor in with it. The rotor and the necessary train of reducing gears rotate in oil sealed in a

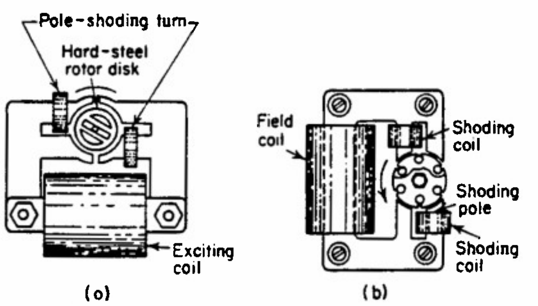

Fig. 15.1.74 Synchronous motors for timing. (*a*) Warren Telechron motor; (*b*) Holtz induction-reluctance subsynchronous motor.

small metal can. Figure 15.1.74*b* shows a subsynchronous motor. Six squirrel-cage bars are inserted in six slots of a solid cylindrical iron rotor, and the spaces between the slots form six salient poles. The motor, because of the squirrel cage, starts as an induction motor, attempting to attain the speed of the rotating field, or 3,600 r/min (at 60 Hz). However, when the rotor reaches 1,200 r/min, one-third synchronous speed, the salient poles of the rotor lock in with the poles of the stator and hold the rotor at 1,200 r/min.

AD-DC CONVERSION

Static Rectifiers

Silicon devices, and to a lesser extent gas tubes, are the primary means of ac to dc or dc to ac conversion in modern installations. They are advantageous when compared to synchronous converters or motor generators because of efficiency, cost, size, weight, and reliability. Various bridge configurations for single-phase and three-phase applications are shown in Fig. 15.1.75*a*. Table 15.1.15 shows the relative outputs of rectifier circuits. The use of two three-phase bridges fed from an ac source consisting of a three-winding transformer with both a Δ and Y secondary winding so that output voltages are 30° out of phase will reduce dc ripple to approximately 1 percent.

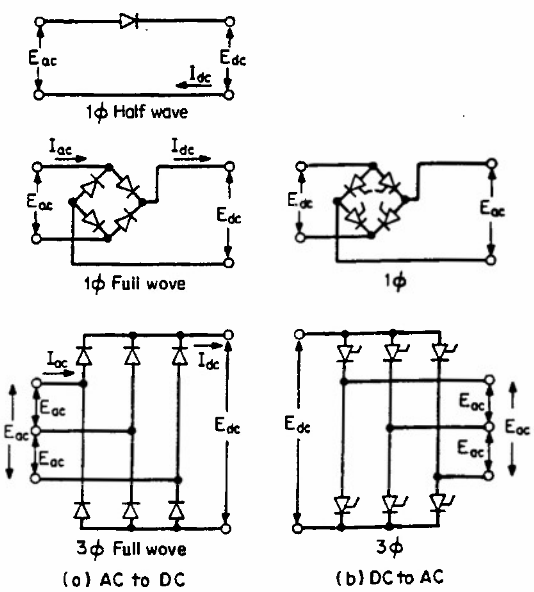

Fig. 15.1.75 AC-DC conversion with static devices.

A.5.E5-12

Price $ 5.00

13-6-611
1st Edition

GARDNER-DENVER®

MODELS: MCYA_B
MCYE_B
MCYK_B
MCYM_B

COMPRESSORS FOR INDUSTRIAL SERVICE

COMPRESSOR SERIAL NO. PA-610 GB-602 PA-611 GB-603

COMPRESSOR MODEL NO. MCYMH

SIZE 14 3/4" & 8 1/2" x 5

600 cfm

13-6-611

Operating and Service Manual

COOPER INDUSTRIES

INDUSTRIAL MACHINERY

A.5.E5-13

CUSTOMER JOHN BROWN /ARMY SHEET 1 OF 4 REV____ DATE____ MTRS

CUSTOMER P.O.# PB-0303-0056 MAT'L. REQ'D. BY 6/16/89 REV____ DATE____ CERT. OF C

B/M FOR 1 UNITS 2 REQ'D. NBR. LIT. REQ'D. 38 REV____ DATE____ ☐ CERT. OF T

ITEM-CODE	QUAN.	DESCRIPTION	SP	REV	PO NBR	SUPPLIER	REC.	PART NBR.
1-2	1	GARDNER DENVER MODEL MCYMH			MCYM-H			
		14 3/4" x 8 1/2 x 5" NON LUBE AIR						
		COMPRESSOR W/INTERCOOLER &						
		SHEAVE						
2-2	1	SIEMENS MOTOR 150 HP, 1800 RPM						
		460/3/60 1.15 SF HIGH EFF.						
		TEFC 445T FRAME						
3-2	1	SLIDE BASE FOR 445-T FRAME						
		MOTOR WITH 2 TENSIONING BOLTS						
4-2	1	BASCO MODEL 05084 AFTERCOOLER						
		TEMA C' DESIGN - ASME						
5-2	1	SOLBERG (OR EQUAL) MODEL						
		FS-274P-600 W/6" FLANGE						
		CONN. AND PAPER ELEMENT						
		AND WEATHER HOOD						
6-2	1	DAYTON FLEX HOSE STOCK NO.						
		4Z490 3" 150# FLANGE CONN.						

A.5.E5-14

ECO-H1

Modifications and improvements to the steam distribution system.

Option A - Repair existing steam pipe and fittings.

Option B - Install new a steam distribution piping system.

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-H1
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: P B ARSENAL REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: ECO-H1 IMPROVE STEAM DISTRIBUTION SYSTEM
FISCAL YEAR 1997 DISCRETE PORTION NAME: OPTION A - REPAIR EXISTING
ANALYSIS DATE: 07-01-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

A. CONSTRUCTION COST	$ 69572.		
B. SIOH	$ 4175.		
C. DESIGN COST	$ 4175.		
D. TOTAL COST (1A+1B+1C)	$ 77922.		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F. PUBLIC UTILITY COMPANY REBATE		$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 77922.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 16.79	0.	$ 0.	15.08	$ 0.
B. DIST	$ .00	0.	$ 0.	18.57	$ 0.
C. RESID	$ .00	0.	$ 0.	21.02	$ 0.
D. NAT G	$ 2.81	168000.	$ 472080.	18.58	$ 8771246.
E. COAL	$ .00	0.	$ 0.	16.83	$ 0.
F. PPG	$ .00	0.	$ 0.	17.38	$ 0.
M. DEMAND SAVINGS			$ 0.	14.88	$ 0.
N. TOTAL		168000.	$ 472080.		$ 8771246.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 0.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 472080.

5. SIMPLE PAYBACK PERIOD (1G/4) .17 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 8771246.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 112.56
(IF < 1 PROJECT DOES NOT QUALIFY)

A.5.H1-2

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: ECO-H1
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID FY95 (92)

INSTALLATION & LOCATION: P B ARSENAL REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: ECO-H1 IMPROVE STEAM DISTRIBUTION SYSTEM
FISCAL YEAR 1997 DISCRETE PORTION NAME: OPTION B - NEW PIPING
ANALYSIS DATE: 07-01-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

A. CONSTRUCTION COST	$ 5041913.		
B. SIOH	$ 302515.		
C. DESIGN COST	$ 302515.		
D. TOTAL COST (1A+1B+1C)	$ 5646943.		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F. PUBLIC UTILITY COMPANY REBATE		$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 5646943.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 16.79	0.	$ 0.	15.08	$ 0.
B. DIST	$ .00	0.	$ 0.	18.57	$ 0.
C. RESID	$ .00	0.	$ 0.	21.02	$ 0.
D. NAT G	$ 2.81	168000.	$ 472080.	18.58	$ 8771246.
E. COAL	$ .00	0.	$ 0.	16.83	$ 0.
F. PPG	$ .00	0.	$ 0.	17.38	$ 0.
M. DEMAND SAVINGS			$ 0.	14.88	$ 0.
N. TOTAL		168000.	$ 472080.		$ 8771246.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 0.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 472080.

5. SIMPLE PAYBACK PERIOD (1G/4) 11.96 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 8771246.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 1.55
(IF < 1 PROJECT DOES NOT QUALIFY)

ECO-H1 CALCULATIONS

ESTIMATE OF ENERGY LOSS FROM STEAM LEAKS

The energy losses due to steam leaks within Production Areas 31, 32, 33 and 34 were estimated by performing a monthly natural gas balance for the entire Arsenal for calendar year 1995. This involved subtracting all identified steam consumption and steam losses from the total natural gas consumption for the Arsenal. Steam consumption at PBA includes process heating, process humidification and comfort heating. Steam losses include condensate leaks, thermal losses due to conduction and convection, system (boiler) efficiency and steam leaks. The methods used for identifying and calculating the natural gas consumption for all of the identified users and losses are described in the following paragraphs.

All of the identified steam leaks are located in production areas 31, 32, 33, and 34. The steam system in area 44 is very small and any leaks associated with this system are negligible. The natural gas used in these areas is equal to the total natural gas energy supplied to the arsenal less the sum of the natural gas consumed by all other buildings within the Arsenal. The following equation was used to determine the natural gas consumption by the steam systems in Production Areas 31, 32, 33, 34, and 44:

$$\Sigma SS_P = NG_B - \Sigma IB_M \qquad (1)$$

Where:

ΣSS_P = The monthly natural gas consumption for the steam systems (production and distribution) in Areas 31, 32, 33, 34 and 44.

NG_B = Total monthly facility natural gas consumption as shown on the monthly bills from the supplier.

ΣIB_M = Sum of the monthly natural gas use for the 71 individual buildings with working natural gas meters.

The natural gas supply for PBA is provided through a single supply line and main meter. The monthly readings from the main meter are the basis for determining the total monthly natural gas consumption (NG_B) at PBA and the monthly billing by the natural gas supplier. The natural gas is then distributed to approximately 75 buildings within the Arsenal. These facilities are equipped with plurality functioning gas flow meters that are read on the 25th of every month.

Ideally, the total natural gas consumption at PBA (as shown on the monthly bill) would be equal to the sum of the natural gas use for the 75 individually metered buildings. However, the meters for the boiler houses in Areas 32, 33, 34, & 44 have reportedly been broken for some time and no readings

are taken for these buildings. The natural gas consumption for all of the other 71 buildings with working meters (including the laundry and incinerator) was calculated from the meter readings. The natural gas consumption of these facilities was totaled on an monthly basis. These monthly totals are used as IB_M in the natural gas balance equations.

The natural gas consumed by the steam systems in the production areas is divided into three main groups: process steam use, comfort heating, and steam production and distribution system losses. This is described by the following equation.

$$\Sigma SS_P = PE_P + CH_P + SL_P \qquad (2)$$

Where:

PE_P = Process steam used for process heating and humidification.

CH_P = Energy used for comfort (space) heating.

SL_P = System losses from the steam production and distribution system.

Process steam energy is defined as steam heating or humidification utilized for the direct production of a product. The steam demand for process heating/humidification and for comfort heating for each building within the production areas is defined in Exhibit F of the Contingency Master Planning Program Steam and Compressed Air Utility Study prepared by CDG in October 1994 (CDG Utility Study). Steam demand values given in the CDG Utility Study were checked and updated by the Production staff. Total energy consumption for the steam systems in the production areas is therefore equal to the summation of the energy requirements for each area.

$$PE_P = PS_{31} + PS_{32} + PS_{33} + PS_{34} + PS_{44} \qquad (3)$$

Where:

PS_{31} = Process steam consumption in production area 31.

PS_{32} = Process steam consumption in production area 32.

PS_{33} = Process steam consumption in production area 33.

PS_{34} = Process steam consumption in production area 34.

PS_{44} = Process steam consumption in production area 44.

System losses (SL_P) from the steam production and distribution system include conversion losses from changing the chemical energy of the natural gas to steam energy (boiler efficiency), thermal losses due to convection and conduction from the distribution system piping, losses as a result of not returning the warm condensate, and losses due to steam leaks from the distribution system piping. The losses from the steam system are described by the following equation:

$$SL_P = CL_P + TL_P + LEAKS_P \quad (4)$$

Where:

CL_P = Energy losses from condensate system leaks.

TL_P = Thermal energy losses through the pipe insulation.

$LEAKS_P$ = Leaks from the steam distribution system.

Boiler efficiency measurements and calculations indicated that the 70 percent efficiency used by the PBA staff was a fairly accurate average. The conversion efficiency losses are taken into account by dividing all of the calculated steam consumption values (in MBtu of steam) for areas 31, 32, 33 and 34 by 0.7 to obtain MBtu of natural gas. The calculated steam consumption values (in MBtu of steam) for area 44 were divided by 0.8 to obtain MBtu of natural gas. Since boiler efficiency is accounted for in the calculations for all of the steam consumption values listed in Equations 1 through 4, a separate term for conversion losses was not included in the system losses equation.

The condensate return system at PBA is in very poor condition and is scheduled for replacement in the near future. Calculations of the natural gas energy losses due to the poor condition of the condensate system assumed approximately 10 percent of the available condensate is currently being returned, the condensate temperature is 120 degrees F and the make-up water temperature is about 68 degrees F.

Thermal losses (TL_P) from the steam supply piping to the atmosphere due to conduction and convection were calculated for each month of the year. The amount of these losses is influenced by the temperature of the pipe and the outside air temperature. Thirty year averages were used for monthly temperatures in these calculations.

By combining equations 1, 2 and 4, and rearranging, the following expression was derived for calculating natural gas use due to steam leaks in the production areas:

$$LEAKS_P = NG_B - IB_M - PE_P - CH_P - CL_P - TL_P \quad (5)$$

Table 3.2-1 PBA Natural Gas Balance for 1995

Natural Gas Component	Estimated Monthly Natural Gas Consumption (MBtu)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1. Natural Gas Bills (NG_B)	72,425	65,166	58,220	47,855	37,697	38,392	37,838	34,199	35,284	41,937	58,597	77,672
2. Bldgs w/ Meters (IB_M)	9,187	10,282	7,633	5,274	2,505	3,814	5,233	5,277	4,505	6,079	6,715	9,367
3. Process Heat (PE_P)	10,181	10,647	12,176	10,759	10,907	11,848	12,357	10,362	10,034	10,181	9,853	10,544
4. Comfort Heat (CH_P)	35,117	27,788	20,787	6,854	2,517	271	73	137	1,322	7,812	18,317	30,387
5. Condensate Loss (CL_P)	4,228	3,669	3,382	2,847	2,353	2,312	2,180	1,934	2,058	2,397	3,469	4,567
6. Conduction Loss (TL_P)	4,564	4,080	4,392	4,116	4,138	3,890	3,971	3,984	3,947	4,234	4,266	4,530
7. Steam Leaks ($LEAKS_P$)	9,148	8,700	9,849	18,005	15,277	16,257	14,024	12,505	13,417	11,234	15,977	18,278

Steam Leaks (7) = (1) - (2) - (3) - (4) - (5) - (6)

The first line of Table 3.2-1 lists the natural gas consumption for the entire Arsenal for each month of 1995. The second line shows the monthly consumption of all buildings within the Arsenal that have working natural gas meters. Line three of Table 3.2-1 lists the calculated natural gas use for process heating and humidification in areas 31, 32, 33, 34 and 44. The estimated natural gas consumption for space (comfort) heating is listed in line four. The monthly estimates of additional natural gas consumption required due to the poor condition of the condensate return system are shown in line five. Line six shows the estimated energy required to overcome the thermal losses through the steam supply pipe insulation. The estimated natural gas consumption that is wasted due to steam leaks is tabulated in line seven.

The estimated losses due to steam leaks are lower during the winter months of January, February and March. Regardless of how and where the steam leaks occur, the driving force for steam leaks is the system operating pressure. Since the boilers and distribution system pressure are kept fairly constant throughout the year, the steam leaks should also remain constant throughout the year. This indicates the actual winter conditions during 1995 were probably milder than the average bin data that was used to calculate the energy use for space heating. Therefore, if the calculated energy use for space heating was decreased to match the actual 1995 energy consumption for space heating, the estimated steam leaks would increase during these winter months.

The estimated energy use for comfort heating during the summer months is negligible. Therefore, the steam leak estimates for these months should more accurately reflect the average value of the actual steam leaks. The average estimated loss due to steam leaks during June, July and August is 14,260 MBtu per month. Based on this value, the economic analyses assume that the steam leaks remain constant at 14,000 MBtu per month throughout the year. Therefore, the total annual estimated energy loss due to steam leaks at the Arsenal is about 168,000 MBtu per year. Using $2.81 per MBtu as the average cost of natural gas, the cost of steam leaks at PBA is approximately $472,000 per year.

To ensure that all of the natural gas consumed at PBA was accounted for, an additional calculation was performed using the consumption data from the boiler logs. The PBA staff estimates the monthly natural gas use for the boiler houses by taking the steam totalizer readings and dividing that value by an assumed boiler efficiency of 70 percent. Our boiler efficiency measurements and calculations indicate the boilers in areas 32, 33 and 34 operate at an average efficiency of about 70 percent and the boiler in area 44 operates at an efficiency of about 80 percent.

The total natural gas consumption at PBA should equal the estimated natural gas use for the boilers in areas 32, 33 and 34 plus the total natural gas use for the 71 metered buildings plus the calculated natural gas use for the boiler in area 44. The estimated natural gas use is a little higher than the actual for the first three months and lower than the actual for the remainder of the year. The annual total of the estimated natural gas use is within about five percent of the actual natural gas use.

PBA Natural Gas Balance														
Nat. Gas Bal. (MBtu/Mo)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total MBtu/yr	Total Cost
Natural Gas Bills (1)	72,425	95,199	59,220	47,955	37,697	39,392	37,939	34,189	35,284	41,937	59,597	77,672	905,292	$1,700,942
Buildings w/ Meters (2)	9,197	10,282	7,633	5,274	2,505	3,914	5,233	5,277	4,505	9,079	9,715	9,397	75,972	$213,200
Process Heat (3)	10,181	10,947	12,176	10,759	10,907	11,849	12,357	10,392	10,034	10,181	9,853	10,544	129,949	$394,975
Condensate Losses (4)	4,229	3,669	3,392	2,847	2,353	2,312	2,180	1,934	2,058	2,397	3,499	4,597	35,395	$99,460
Conduction Losses (5)	4,564	4,080	4,392	4,116	4,139	3,890	3,871	3,994	3,947	4,234	4,296	4,530	50,114	$140,821
Comfort Heating (6)	35,117	27,789	20,787	9,854	2,517	271	73	137	1,322	7,912	18,317	30,397	151,382	$425,382
Steam Leaks (7)	9,148	9,700	9,848	19,005	15,277	16,257	14,024	12,505	13,417	11,234	15,977	19,279	192,971	$457,105
														$1,700,842

(1) Monthly natural gas bills for entire Arsenal from Falling Tree Enterprises.
(2) Monthly totals from the 71 metered buildings at PBA, see attached table.
(3) See Process Energy Use Calculations.
(4) Assumes: 10% of condensate is returned, TC = 120 °F TGW = 69 °F Boiler eff = 70%
(5) See Conduction Loss Calculations.
(6) See Comfort Heating Calculations - Bin Temperature Method.
(7) Steam leaks (7) = (1) - (2) - (3) - (4) - (5) - (6)

PBA Natural Gas Balance - Corrected														
Corr. N.G. Bal. (MBtu/Mo)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total MBtu/yr	Total $
Natural Gas Bills	72,425	95,199	59,220	47,955	37,997	38,392	37,839	34,189	35,284	41,937	58,587	77,672	605,292	$1,700,942
Bldgs w/ Meters	9,197	10,282	7,933	5,274	2,505	3,814	5,233	5,277	4,505	6,079	6,715	9,397	75,972	$213,200
Process Heat	10,181	10,947	12,176	10,759	10,907	11,849	12,357	10,392	10,034	10,181	9,853	10,544	129,949	$394,975
Condensate Losses	4,228	3,969	3,392	2,847	2,353	2,312	2,190	1,934	2,058	2,397	3,469	4,597	35,395	$99,460
Conduction Losses	4,594	4,080	4,392	4,119	4,139	3,880	3,971	3,984	3,947	4,234	4,269	4,530	50,114	$140,921
Comfort Heating (9)	32,953	24,499	20,202	12,196	2,517	271	73	137	394	5,473	21,497	37,820	159,031	$444,097
Steam Leaks	11,412	11,989	10,434	12,662	15,277	16,257	14,024	12,505	14,349	13,572	12,797	10,745	159,021	$438,420
														$1,700,942

Comfort Heating Correction Calculations (actual weather was not the same as the bin data)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Space Heat w/ Summer = 0 (9)	32,953	24,489	20,202	12,199	4,907	4,183	2,220	(1,493)	394	5,473	21,497	37,820
Calculated Corr. Values (10)	2,294	3,289	595	(5,342)	(2,290)	(3,922)	(2,147)	1,900	928	2,339	(3,190)	(7,533)
Comfort Heat Corr. Values (11)	2,264	3,289	585	(5,342)	0	0	0	0	928	2,339	(3,190)	(7,533)

(8) Calculated Comfort Heating (6) - Comfort Heat Corr. Value (11)
(9) Current Month Nat. Gas Use (1) - Aug Nat. Gas Use (1) - (Current metered bldgs use (2) - Jun metered bldgs use(2))
(10) Calculated Comfort Heating (6) - Space Heat w/ Summer = 0 (9)
(11) Values from Item (10) for heating months only.

A.5.H1-9

PINE BLUFF ARSENAL

1995 Monthly Gas Meter Readings

GROUP 1 BUILDINGS																									
Bldg No.	32100	32070	32090	32130	32035	33060	23390	23330	23310	23370	24770	24610	17120	17110	17130		13130	13050	13060	13090	13100	13005	13060	13020		Sub Total
Bldg. Name		Laundry						Supply	LCL	E&T	PDO	Union & Jan Serv.	Moody School Contrac	Moody School Pub. Aff.	Moody School Person.	NCO Capehart			Lab	Training Ofc.					Club & BOQ-Staff Row	Group 1 Buildings
25-Jan-95	224	200	128	27	261	16	1	636	176	62	10	20	79	26	37	500	12	11	51	20	25	6	15	37	153	2747
25-Feb-95	225	186	105	31	341	17	1	623	193	52	11	29	24	30	49	467	39	13	71	43	44	12	62	68	97	2833
25-Mar-95	133	192	49	11	166	6	0	440	86	26	6	15	10	17	17	331	18	213	26	21	18	4	19	24	47	1909
25-Apr-95	44	234	3	1	22	3	0	198	26	11	0	2	2	3	12	187	2	20	3	6	4	1	6	6	39	837
25-May-95	20	170	3	0	14	1	0	95	17	3	0	1	1	1	2	156	3	9	4	6	0	0	4	0	29	541
25-Jun-95	1	204	1	0	3	0	1	11	3	1	0	1	1	0	0	61	2	4	2	0	0	1	0	0	29	346
25-Jul-95	1	249	1	0	3	0	0	5	3	1	0	1	1	0	3	79	2	3	2	1	0	0	0	0	32	367
25-Aug-95	1	178	1	0	4	0	0	4	3	2	0	1	0	0	2	62	2	2	2	0	0	0	0	0	28	310
25-Sep-95	3	189	1	0	3	1	0	28	4	2	0	1	1	0	2	93	2	4	1	0	0	0	0	0	42	377
25-Oct-95	28	322	2	0	4	0	1	128	6	9	0	201	1	1	2	141	3	6	2	3	0	1	1	1	98	963
25-Nov-95	73	137	45	3	102	6	1	354	95	30	7	15	5	20	16	264	11	57	15	15	3	2	14	16	146	1476
25-Dec-95	231	140	99	23	274	16	1	518	301	63	11	30	24	42	44	429	21	112	49	31	10	10	30	43	186	2736

GROUP 2 BUILDINGS																									
Bldg No.	10050		10020	S10030		12410	50610	54010	57160	51570	51570	53100	93500	53160	51420	60090	60400	60060	60070	63120	63010	63110	63200	63220	63410	Sub Total
Bldg. Name	Fire Station	Staff Row	Admin. Bldg.	6RT & Environ.	Farm Hse & Ofcr Capehart	Farm house	BZ Plant Warehse		B2 Plant Ofc		DMMD Portion				Halfway house	Traffic	DMMD Carp. Shop				Dock					Group 2 Buildings
25-Jan-95	117	145	266	59	143	36	35	0	20	43	150	70	52	21	75	6	127	24	121	217	44	26	90	111	110	2110
25-Feb-95	102	163	244	104	149	25	29	0	26	50	430	61	74	9	72	20	217	63	104	266	70	110	141	340	145	3036
25-Mar-95	71	98	190	53	97	14	2	0	14	34	171	44	35	33	44	6	114	23	50	120	37	59	56	114	86	1569
25-Apr-95	36	50	6	15	57	6	2	0	5	23	95	21	17	17	2	3	11	7	20	39	23	2	9	37	62	567
25-May-95	24	30	2	7	46	4	2	0	3	20	65	5	11	3	2	3	7	3	17	17	16	1	2	11	39	340
25-Jun-95	14	12	0	4	29	3	2	0	0	6	16	1	1	3	1	3	3	0	6	1	1	1	1	1	39	150
25-Jul-95	14	12	0	4	26	3	2	0	0	6	13	0	1	3	1	3	4	2	4	1	0	1	1	0	39	142
25-Aug-95	14	13	0	4	29	3	2	0	0	6	13	0	1	4	2	3	4	1	4	1	0	1	1	0	37	145
25-Sep-95	16	16	1	5	34	1	2	0	0	10	15	0	1	1	3	3	5	1	4	17	0	0	1	10	39	165
25-Oct-95	31	27	2	9	46	1	2	1	1	22	27	1	1	5	3	3	16	7	6	36	0	5	6	14	53	331
25-Nov-95	65	93	164	35	79	23	2	6	12	50	47	25	45	27	15	5	100	21	26	164	0	94	37	68	53	1316
25-Dec-95	110	153	264	62	142	21	166	11	29	49	223	62	68	56	40	15	152	44	105	220	48	142	105	176	195	2666

GROUP 3 BUILDINGS																					
Bldg No.	60120	16140	16076	16175	16190	16210	16220	16230	16250	16270	16340	16310	16440	34960	34910	44101	44300	42965	42970	42930	34121	Sub Total
Bldg. Name			Pool	Day Care							PX	Rec. Cntr.	Cred. Union				Dilly Farm		Incin.	CWT	Gate 5	Group 3 Buildings
25-Jan-95	20	51	0	14	67	35	22	21	14	22	4	165	16	7	12	6	0	26	3,711	77	10	4,330
25-Feb-95	51	54	0	4	113	66	56	39	23	24	5	162	10	15	15	7	0	24	3,711	22	10	4,413
25-Mar-95	17	40	0	6	67	42	22	16	11	47	2	99	9	5	16	9	0	22	3,711	12	2	4,155
25-Apr-95	2	14	0	2	33	20	20	5	4	17	2	15	2	1	6	1	0	9	3,711	2	2	3,870
25-May-95	0	6	0	0	7	4	7	6	1	2	2	12	0	1	2	0	0	9	1,556	5	2	1,624
25-Jun-95	0	2	2	0	23	4	4	5	0	2	2	33	0	0	10	0	0	3	3,227	1	0	3,316
25-Jul-95	0	3	1	0	22	5	3	4	0	1	2	16	0	0	7	0	0	3	4,633	2	0	4,704
25-Aug-95	0	3	1	0	17	5	1	5	0	1	2	31	0	0	6	0	0	2	4,745	2	1	4,822
25-Sep-95	0	3	1	0	16	5	9	5	0	1	2	10	0	0	6	0	0	5	3,673	2	1	3,943
25-Oct-95	1	3	1	0	16	5	14	6	2	1	2	16	0	3	10	0	0	10	4,687	2	2	4,765
25-Nov-95	17	32	0	5	66	21	3	32	12	3	2	55	8	10	6	5	14	22	3,593	9	4	3,923
25-Dec-95	43	67	0	10	111	39	22	36	22	30	9	70	15	13	9	0	27	26	3,374	23	9	3,965

TOTALS					
Sub Total Group 1 Buildings (above)	Sub Total Group 2 Buildings (above)	Sub Total Group 3 Buildings (above)	SubTotal Sum of All Meters	PBA Total 1995 Gas Bills (MBTU)	Boilers Areas 31, 32, 33, 34, 44
2747	2110	4,330	9,187	72,425	63,236
2833	3036	4,413	10,282	65,166	54,884
1909	1569	4,155	7,633	56,220	50,587
837	567	3,870	5,274	47,655	42,501
541	340	1,624	2,505	37,097	35,192
346	150	3,316	3,814	36,392	34,578
367	142	4,704	5,233	37,836	32,605
310	145	4,822	5,277	34,199	28,922
377	165	3,943	4,505	35,264	30,779
963	331	4,765	6,079	41,937	35,856
1476	1316	3,923	6,715	56,597	51,862
2736	2666	3,965	9,367	77,072	66,305
			75,872	605,282	529,410

A.5.H1-10

Process Energy Use Calculations		
	Steam	N. Gas
Natural Gas Demand - Calcs	lbs/hr	MBtu/hr
	(1)	(2)
Process Area 31 (3)	375	0.54
Process Area 32 (3)	637	0.91
Process Area 33 (3)	75	0.11
Area 34 Operational (4)	21158	30.23
Area 34 Stand By (5)	8463	12.09
Process Area 44	33	0.04
Totals	30,741	43.91

NOTES:

(1) From 1994 CDG Utility Study updated by PBA Production staff.

(2) Assumes 1000 Btu/lb of steam, boiler efficiency = 70% for areas 32, 33 & 34 and 80% for area 44.

(3) Assumes the production operating level is: 50% of maximum capacity.

(4) Assumes WP production operating level is: 50% of maximum capacity.

(5) Assumes WP stand-by energy use level is: 40% of maximum capacity.

(6) From The Weather Almanac, Fourth Edition, 30 year average monthly temperatures.

(7) From WP Production Schedule dated March 6, 1996.

(8) N. Gas MBtu/hr x Oper. Hrs/Mo + Stand-by N. Gas x (Total Hours/Month - Oper. Hrs/Mo)

(9) N. Gas MBtu/hr x Total Hours/Month

Operating and Weather Data													
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Totals
Average OA Temp. (6)	41.4	44.6	53	62.4	70.2	78.2	81.5	80.6	74.2	63.7	51.9	43.7	
Days per month	31	28	31	30	31	30	31	31	30	31	30	31	365
Total Hours/Month	744	672	744	720	744	720	744	744	720	744	720	744	8760
Area 34 Op. Hrs/Mo (7)	0	80	110	50	40	110	120	10	10	0	0	20	550
Process Energy (MBtu/Mo)													
Area 34 (8)	8995	9576	10990	9612	9721	10700	11172	9177	8887	8995	8705	9358	115,887
Area 31 (9)	399	360	399	386	399	386	399	399	386	399	386	399	4,693
Area 32 (9)	677	611	677	655	677	655	677	677	655	677	655	677	7,969
Area 33 (9)	80	72	80	77	80	77	80	80	77	80	77	80	939
Area 44 (9)	31	28	31	30	31	30	31	31	30	31	30	31	361
Total Process Heating	10,181	10,647	12,176	10,759	10,907	11,848	12,357	10,362	10,034	10,181	9,853	10,544	129,849

A.5.H1-11

EXHIBIT F
STEAM DEMAND FOR MOBILIZATION CONDITION

CDG UTILITY STUDY

EQUIPMENT EFFECTIVNESS FACTOR %

STEAM DEMANDS

PINE BLUFF ARSENAL, ARKANSAS
DEPARTMENT OF THE ARMY

BUILDING NUMBER	BLDG USE	VENILATION CFM	HEATIING LOAD LBS STEAM/HR	CURRENT DEMAND STEAM PROCESS LOAD LBS STEAM/HR	TOTAL LOAD LBS STEAM/HR	PARTIAL BASELINE EMERGENCY STEAM PROCESS LOAD LBS STEAM/HR	TOTAL LOAD LBS STEAM/HR	BASELINE EMERGENCY STEAM PROCESS LOAD LBS STEAM/HR	TOTAL LOAD LBS STEAM/HR
31080	ELECTRONIC CALIBRATION FACILITY		349.99		349.99		349.99		349.99
31100	MAINT FACILITY		1,730.12		1,730.12		1,730.12		1,730.12
31150	PRODUCTION OFFICE		248.92		248.92		248.92		248.92
31310	RAW MAT. WAREHOUSE		1,837.00		1,837.00		1,837.00		1,837.00
31330	RAW MAT. WAREHOUSE		1,837.00		1,837.00		1,837.00		1,837.00
31420	RAW MAT. WAREHOUSE		1,837.00		1,837.00		1,837.00		1,837.00
31440	RAW MAT. WAREHOUSE		1,837.00		1,837.00		1,837.00		1,837.00
31520	MIX BUILDING	15,290	2,005.00		2,005.00		2,005.00		2,005.00
31530	FILL AND PRESS	29,010	3,728.00	750 750	4,478.00	1500	5,228.00	1500	5,228.00
31531	OFFICE AND RESTROOMS		239.26		239.26		239.26		239.26
31540	DOWNLOAD FACILITY		947.03		947.03		947.03		947.03
31570	MUNITIONS STORAGE		1,187.97		1,187.97		1,187.97		1,187.97
31620 L	PYRO MIX BLDG (THERMATE MIX)	14,860	0 1,949.00	0 20	1,969.00	20	1,969.00	20	1,969.00
31630 L	FILL AND PRESS	10,000	0 2,852.19	0 300	3,152.19	0	2,852.19	500	3,352.19
31631	BREAK AND RESTROOMS		239.26		239.26		239.26		239.26
31640	ASSEMBLY		947.03		947.03		947.03		947.03
31670	STORAGE		1,187.97		1,187.97		1,187.97		1,187.97
31720 L	PYROTECHNIC PRODUCTION	2,870	0 454.00	0 100	554.00	100	554.00	100	554.00
31730	STORAGE		149.86		149.86		149.86		149.86
31820	STORAGE		301.43		301.43		301.43		301.43
31830	AMMO QUAL FAC		149.86		149.86		149.86		149.86
31860	STORAGE		159.50		159.50		159.50		159.50
			20919 26,174.42	750 1,170.00	27,344.42	1,620.00	27,794.42	2,120.00	28,294.42
32000	CAFETERIA		512.16		512.16		512.16		512.16
32030	INSPECTION GARAGE		706.04		706.04		706.04		706.04
32035	ORDINANCE SHOP		0.00		0.00		0.00		0.00
32070	IMPREG AND LAUNDRY		1,909.25	93	2,002.25	93	2,002.25	93	2,002.25
32080	MHE BATTERY SHOP		349.99		349.99		349.99		349.99
32090	WAREHOUSE		855.31		855.31		855.31		855.31
32100	ELECTRONIC CALIBRATION FACILITY		1,730.12		1,730.12		1,730.12		1,730.12
32130	AMMO QUAL FAC		561.96		561.96		561.96		561.96
32150	AMMO QUAL FAC		248.92		248.92		248.92		248.92
32230	FILTER BLDG		1,628.91		1,628.91		1,628.91		1,628.91
32270	WAREHOUSE		1,628.91	0	1,628.91	0	1,628.91	0	1,628.91
32310	RAW MAT. WAREHOUSE		1,837.00		1,837.00		1,837.00		1,837.00
32330	RAW MAT. WAREHOUSE		1,837.00		1,837.00		1,837.00		1,837.00
32420	RAW MAT. WAREHOUSE		1,837.00		1,837.00		1,837.00		1,837.00
32440	EQUIPEMENT WAREHOUSE		1,837.00		1,837.00		1,837.00		1,837.00
32510	PROD ENGR LAB		518.13		518.13		518.13		518.13
32520	PROD ENGR LAB		1,067.96		1,067.96		1,067.96		1,067.96
32530	FORMER BZ FACILITY		2,543.52		2,543.52		2,543.52		2,543.52
32531			151.46		151.46		151.46		151.46

A.5.H1-12

EXHIBIT F
STEAM DEMAND FOR MOBILIZATION CONDITION

CDG UTILITY STUDY

EQUIPMENT EFFECTIVNESS FACTOR %

STEAM DEMANDS

PINE BLUFF ARSENAL, ARKANSAS
DEPARTMENT OF THE ARMY

BUILDING NUMBER	BLDG USE	VENILATION CFM	HEATIING LOAD LBS STEAM/HR	CURRENT DEMAND STEAM PROCESS LOAD LBS STEAM/HR	TOTAL LOAD LBS STEAM/HR	PARTIAL BASELINE EMERGENCY STEAM PROCESS LOAD LBS STEAM/HR	TOTAL LOAD LBS STEAM/HR	BASELINE EMERGENCY STEAM PROCESS LOAD LBS STEAM/HR	TOTAL LOAD LBS STEAM/HR
32540	FORMER BZ FACILITY		947.03		947.03		947.03		947.03
32550	AMMO QUAL FAC		353.92		353.92		353.92		353.92
32570	OPERATIONS GENERAL PURPOSE		1,209.30		1,209.30		1,209.30		1,209.30
32610	DRYING	14,900	1,705.00	7.26	1,712.26	7.26	1,712.26	7.26	1,712.26
32620	COLORED SMOKE MIX (GLATT)	15,290	2,005.00	100% OA 436	2,441.00	872	2,877.00	872	2,877.00
32630	STORAGE		1,673.76		1,673.76		1,673.76		1,673.76
32631	OFFICE AND RESTROOMS		239.26		239.26		239.26		239.26
32640	PYROTECHNIC PRODUCTION	12,510	2,206.10	100	2,206.10		2,206.10		2,206.10
32670	SUU-7 TEST		1,187.97		1,187.97		1,187.97		1,187.97
32720	PROD ENGR LAB		418.58		418.58		418.58		418.58
32730	PROD ENGR LAB		173.74		173.74		173.74		173.74
32820	MATERIAL STORAGE		301.43		301.43		301.43		301.43
32830	MATERIAL STORAGE		149.86		149.86		149.88		149.86
32860	STORAGE		159.50		159.50		159.50		159.50
			34,491.10	636 536.26	35,027.36	972.26	35,463.36	972.26	35,463.36
33080	SAFETY EQUIP		349.99		349.99		349.99		349.99
33100	CHANGE HOUSE		1,730.12		1,730.12		1,730.12		1,730.12
33150	PRODUCTION		248.92		248.92		248.92		248.92
33310	RAW MAT. WAREHOUSE		1,837.00		1,837.00		1,837.00		1,837.00
33330	RAW MAT. WAREHOUSE		1,837.00		1,837.00		1,837.00		1,837.00
33420	RAW MAT. WAREHOUSE		1,837.00		1,837.00		1,837.00		1,837.00
33440	RAW MAT. WAREHOUSE		1,837.00		1,837.00		1,837.00		1,837.00
33520	MIX BUILDING	16,610	1,944.00		1,944.00		1,944.00		1,944.00
33530	FILL AND PRESS	26,900	4,675.86	50	4,725.86	50	4,725.86	50	4,725.86
33531	PUBLIC TOILET		239.26		239.26		239.26		239.26
33540	STORAGE		948.37		948.37		948.37		948.37
33550	IN PROCESS STORAGE		388.02		388.02		388.02		388.02
33570	LAP		1,187.97	0	1,187.97	0	1,187.97	0	1,187.97
33620	STARTER MIX BUILDING		1,067.96	100	1,167.96	100	1,167.96	100	1,167.96
33630 (1)	FILL AND PRESS	10,000	0 2,420.61	0	2,420.61	300	2,720.61	300	2,720.61
33631	OFFICE AND RESTROOMS		239.26		239.26		239.26		239.26
33640	ASSEMBLY BUILDING		947.03		947.03		947.03		947.03
33650	IN PROCESS STORAGE		353.92		353.92		353.92		353.92
33670	M116 LAP		1,187.97		1,187.97		1,187.97		1,187.97
33720	KC103 PROP		301.43		301.43		301.43		301.43
33730	QC TEST FAC		149.86		149.86		149.86		149.86
33820	STARTER MIX SLUGS		301.43		301.43		301.43		301.43
33830	COMPONENT STORAGE		149.86		149.86		149.86		149.86
33860	STORAGE IGLOO		159.50		159.50		159.50		159.50
			23919 26,339.36	150 150.00	26,489.36	450.00	28,789.36	450.00	28,789.36

A.5.H1-13

CGD UTILITY STUDY

EXHIBIT F
STEAM DEMAND FOR MOBILIZATION CONDITION

EQUIPMENT EFFECTIVNESS FACTOR %

PINE BLUFF ARSENAL, ARKANSAS
DEPARTMENT OF THE ARMY

STEAM DEMANDS

BUILDING NUMBER	BLDG USE	VENILATION CFM	HEATIING LOAD LBS STEAM/HR	CURRENT DEMAND STEAM PROCESS LOAD LBS STEAM/HR	TOTAL LOAD LBS STEAM/HR	PARTIAL BASELINE EMERGENCY STEAM PROCESS LOAD LBS STEAM/HR	TOTAL LOAD LBS STEAM/HR	BASELINE EMERGENCY STEAM PROCESS LOAD LBS STEAM/HR	TOTAL LOAD LBS STEAM/HR
34110	WP FILLING	139,310	16,957.00	10602.42	27,559.42	14136.56	31,093.56	14136.56	31,093.56
34120	AMMO QUAL FAC		1,221.45		1,221.45		1,221.45		1,221.45
34130	WP UNLOAD TANKS		474.95	7555.06	8,030.01	7555.06	8,030.01	7555.06	8,030.01
34170	WP BULK STORAGE			21659.27	21,659.27	21659.27	21,659.27	21659.27	21,659.27
34350	ASSEMBLY AND PACKOUT		879.89		879.89		879.89		879.89
34370			331.19		331.19		331.19		331.19
34420			319.82		319.82		319.82		319.82
34430	RAW MATERIAL WAREHOUSE		1,861.28		1,861.28		1,861.28		1,881.28
34620			1,768.37		1,768.37		1,768.37		1,768.37
34630	PYROTECHNIC PRODUCTION	8,000	2,270.12	1200	3,470.12	1200	3,470.12	1200	3,470.12
34640	HC MIX	57,820	5,761.00	1200	5,761.00		5,761.00		5,761.00
34650	START MIX SLEEVE		1,369.83	100	1,369.83		1,369.83		1,369.83
34660	SUB ASSEMBLY		326.47		326.47		326.47		326.47
34820	STORAGE		159.50		159.50		159.50		159.50
34910	FE MAINTENANCE SHOP		9,832.65		9,632.65		9,632.65		9,632.65
34970	ADMIN BUILDING		451.97		451.97		451.97		451.97
			43,785.48	42317 41,016.75	84,802.23	44,550.89	88,336.37	44,550.89	88,336.37
42960	GRENADE TEST BUILDING		421.00		421.00		421.00		421.00
44110	LAP		3,957.49	33	3,990.49	33	3,990.49	33	3,990.49
			135,168.85	42,906.01	178,074.86	47,628.15	182,795.00	48,126.15	183,295.00

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A.5.H1-14

RS&H

SUBJECT: WP Energy Use
AEP NO: 694 1331 004
SHEET ___ OF ___
DESIGNER: W. Todd
DATE: 6-12-96
CHECKER: ___
DATE: ___

Estimate Steam Demand for WP Area:

Bldg. No.	Building Name	Max. lb/hr	Oper. lb/hr	Stdby lb/hr
34110	WP Filling	10600 (1)	10600 (2)	8480 (5)
34130	WP Unload Tanks	7550	750 (3)	-0- (6)
34170	WP Bulk Storage	21660	6500 (4)	6500 (4)
34630	Pyrotechnic Prod.	1200	1200 (2)	-0- (6)
34640	HC Mix	1200	1200 (2)	-0- (6)
34650	Start Mix Sleeve	100	100 (2)	-0- (6)
	Totals	42310	20350	14980

$$\text{Oper. \%} = \frac{20350}{42310} = 48.1\% \Rightarrow \text{say } 50\%$$

$$\text{Stand by \%} = \frac{14980}{42310} = 35.4\% \Rightarrow \text{say } 40\%$$

(1) From CDG Utility Study see attached copies.
(2) Assume these operations are at or near 100% utilizied.
(3) Assume this is a batch process operating 10% of the time.
(4) Assume after WP is at its production temperature, that 30% of energy is required to maintain the temperature (overcome the thermal losses)
(5) Assume 80% of energy is used during stand-by. See attached telephone call confirmation with E&T staff.
(6) Assume thess operations are shut down during stand-by.

RS&H
Reynolds, Smith and Hills, Inc.
Architectural, Engineering, Planning and Environmental Services

Telephone Call Confirmation

Date: June 12, 1996

Project Number: 694-1331-004

Project Name: PBA Electric and Heating Study

Received: **Placed:** by W. Todd

Local: **Long Dist.:** 501-540-2918

Conversed with: Pat Lawrence

of Pine Bluff Arsenal E&T Division

Regarding: Steam energy consumption for the WP area.

During the last five years the WP production building has been operating one line out of the four available lines (two wet fill and two dry fill).

During Production:

- Dry fill lines use more energy than wet fill lines.
- One-half of the leak test ovens are on only during the shift.
- WP transport pipes are kept hot.

During Stand-by (nights and weekends):

- Dry fill and wet fill cabinets kept hot.
- All of the leak test ovens are off.
- WP transport pipes are kept hot.

During Extended Stand-by (when no production for about one month):

- Almost everything will be turned off.

Distribution: PBA File

By William T. Todd, PE

A.5.H1-16

SIOPB-PWN

5 March 1996

WP Production Schedule

	No. Shifts Per Month	Hrs Worked Per Shift	Hrs Worked Per Month
Feb 95	8	10	80
Mar 95	11	10	110
Apr 95	5	10	50
May 95	4	10	40
Jun 95	11	10	110
Jul 95	12	10	120
Aug 95	1	10	10
Sep 95	1	10	10
Oct 95	0	0	0
Nov 95	0	0	0
Dec 95	2	10	20
Jan 96	0	0	0
Feb 96	0	0	0
	55 [illegible]	TOTAL HRS WORKED:	550

NOTE: Each shift consists of 10 hrs, 0630 - 1700 hrs, four days/week.

A.5.H1-17

Comfort Heating Calculations - Bin Temperature Method						
Design IAT =	70	°F		(1)	From ASHRAE Handbook, 1981 Fundementels.	
Belence Temp =	65	°F		(2)	From CDG Utility Study updated by PBA Production steff. Steem demend reduced by	
Design OAT (1) =	16	°F			30% for CDG's aesumad lossee & by (Bal T-Dee OAT)/(Dee IAT - 0°), boiler eff = 70%.	
Heeting Loed (2) =	89.2	MBtu/Hr		(3)	Bin tempereture data from Engineering Weather Data, TM 5-785.	
				(4)	Percent Load = (Balence Temp - OA Temp) / (Belence Temp - Dasign OAT)	
				(5)	MBtu = Heating Load x Parcent Load x Houre	

OA Temp	% Load	Jen		Feb		Mar		Apr		Mey		Jun	
												Hours	MBtu
(3)	(4)	Hours (3)	MBtu (5)	Hours	MBtu	Houre	MBtu	Houre	MBtu	Hours	MBtu	24	131
62	6%	36	197	32	175	77	421	127	694	95	519	8	117
57	16%	44	641	49	714	92	1340	105	1530	55	801	1	24
52	27%	54	1279	71	1681	103	2439	83	1965	29	687		0
47	37%	81	2655	96	3147	115	3770	43	1410	13	426		0
42	47%	103	4315	117	4901	112	4692	21	880	2	84		0
37	57%	108	5508	102	5202	75	3825	5	255		0		0
32	67%	122	7333	91	5469	44	2645	2	120		0		0
27	78%	84	5814	60	4153	17	1177		0		0		0
22	88%	48	3759	21	1645	5	392		0		0		0
17	98%	23	2011	7	612	1	87		0		0		0
12	100%	11	982	1	89	0	0		0		0		0
7	100%	5	446	0	0	0	0		0		0		0
2	100%	2	178	0	0	0	0		0		0		271
	Totele		35117		27788		20787		6854		2517		

OA Temp	% Load	Jul		Aug		Sep		Oct		Nov		Dec	
												Hours	MBtu
(3)	(4)	Hours (3)	MBtu (5)	Houre	MBtu	Houre	MBtu	Houre	MBtu	Houre	MBtu	44	240
62	6%	8	44	17	93	63	344	123	672	86	470	62	903
57	16%	2	29	3	44	38	554	109	1588	102	1486	77	1823
52	27%		0		0	12	284	90	2131	122	2889	107	3508
47	37%		0		0	3	98	55	1803	106	3475	129	5404
42	47%		0		0	1	42	26	1089	86	3603	121	6171
37	57%		0		0		0	8	408	61	3111	85	5109
32	67%		0		0		0	2	120	33	1983	57	3945
27	78%		0		0		0		0	13	900	24	1880
22	88%		0		0		0		0	4	313	13	1137
17	98%		0		0		0		0	1	87	3	268
12	100%		0		0		0		0		0	0	0
7	100%		0		0		0		0		0	0	0
2	100%		0		0		0		0		0		30387

A.5.H1-18

2

Conduction Loss Calculations

Pipe Temperature = 350.1 °F (for 120 psig, see attached steam tables)

Insultion Thickness = 2.5 inches

Nominal	Pipe IR	Steam	Pipe OR	Still Air	Ins. OR	Out. Air	k pipe (1)	k ins (1)	Pipe	Steam (3)	N. Gas (4)
Pipe Dia.	r_a (ft)	h_a (1)	r_b (ft)	h_b (1)	r_c (ft)	h_c (1)	B•ft/h•sf°F	B•ft/h•sf°F	Lnth Ft (2)	Btu/hr°F	MBtu/hr°F
1"	0.0874	2000	0.0985	1.65	0.307	6.00	27	0.03	5280	744	0.0011
2"	0.172	2000	0.185	1.65	0.393	6.00	27	0.03	3960	863	0.0012
3"	0.256	2000	0.274	1.65	0.482	6.00	27	0.03	3960	1161	0.0017
4"	0.336	2000	0.355	1.65	0.564	6.00	27	0.03	3960	1431	0.0020
5"	0.421	2000	0.442	1.65	0.650	6.00	27	0.03	3960	1716	0.0025
6"	0.505	2000	0.529	1.65	0.737	6.00	27	0.03	15840	7995	0.0114
										Total	0.0199

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
OAT (5)	41.4	44.6	53	62.4	70.2	78.2	81.5	80.6	74.2	63.7	51.9	43.7
Hrs/Mo	744	672	744	720	744	720	744	744	720	744	720	744
MB/Mo (6)	4564	4080	4392	4116	4138	3890	3971	3984	3947	4234	4266	4530

(1) From the Mechanical Engineering Review Manual, Table 3.2 and Table 3.3, see attached pages.
(2) Pipe length estimated from General Heating Maps for PBA, pages 73 and 74.
(3) From the Mechanical Engineering Review Manual, Equation 3.15, page 3-6, see attached.
(4) N. Gas MBtu/hr°F = (Steam Btu/hr°F / boiler eff.) x (1MBtu / 1000000Btu), assumes boiler eff. = 70%.
(5) Average outside air temperatures from The Weather Almanac, Fourth Edition, 30 year average monthly temperatures.
(6) Conduction Losses MBtu/Mo = N. Gas MBtu/hr°F x (Pipe Temp - OAT) x Hrs/Mo.

A.5.H1-19

At common temperatures, conductivity in solids varies according to

$$k(T) = k_o(1 + \gamma T) \qquad 3.3$$

γ is positive for amorphous materials and insulators (e.g., brick, graphite, etc.) and negative for crystalline materials (with the exceptions of aluminum and brass). Tabulated values of γ are not common, having been replaced with tabulations of k itself versus T for various common materials. In most calculations, the average thermal conductivity (conductivity at the arithmetic mean temperature) is used, and no other attention is paid to variations in conductivity with temperature.

In liquids, heat is transmitted by longitudinal vibrations, similar to sound waves. According to Bridgeman (1921),

$$k = \frac{3k^*a}{d^2} \qquad 3.4$$

Conductivity in water and aqueous solutions increases with increases in temperature up to around 250°F, and then gradually decreases. Conductivity decreases with increased concentrations of aqueous solutions, as it does with most other liquids. Conductivity increases with increases in pressure. Of the non-metallic liquids, water is the best thermal conductor.

The net transport theory can be used to explain heat conduction through gases. Hot molecules move faster than cold molecules, traveling to cold areas with greater frequency than cold molecules travel to hot areas. It can be shown that

$$k = \frac{N\bar{v}fk^*\lambda}{6} \qquad 3.5$$

Conductivity in gases increases almost linearly with increases in temperature, but is fairly independent of pressure in common ranges.

The table below gives the thermal conductivities for some of the more common materials. The back of this chapter has a more extensive list. Notice that BTU-ft/hr-ft^2-°R is the same as BTU/hr-°R-ft. However, these are not the same as BTU-in/hr-°R-ft^2 which is also widely used. Multiply cal-cm/sec-°K-cm^2 by 241.9 to get ft-English units.

Table 3.2

Typical Thermal Conductivities, BTU-ft/hr-ft^2-°R

Material	k	Material	k	Material	k
Silver	242	Lead	20.	Hydrogen	.11
Copper	224	Ice	1.3	Fiberglass	.03
Aluminum	117	Concrete	.5	Cork	.025
Brass	56	Glass	.63	Air	.014
Steel 1%C	27	Water	.32	Oxygen	.016

All of the above conductivities were evaluated at 32°F except hydrogen which was evaluated at 100°F.

A.5.H1-20

2. Conduction

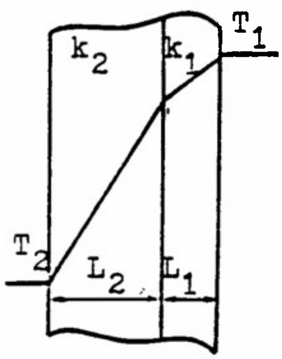
Conduction, the flow of heat through solids, is given by Fourier's law:

$$q = kA\left(\frac{dT}{dL}\right) \tag{3.6}$$

If the heat transmission is steady and both k and A are constant, heat flow through a single slab of thickness L is given by equation 3.7:

Figure 3.1

$$q = kA\Delta T/L \tag{3.7}$$



The heat flow due to conduction for composite sandwiched materials, as shown in Figure 3.1, is:

$$q = \frac{A\Delta T}{\Sigma\left(\frac{L_i}{k_i}\right)} \tag{3.8}$$

To further complicate the problem, there is usually a film on the exposed surfaces. There may also be a film between layers, although perfect bonding is usually assumed.

To account for films on exposed surfaces without having to measure the film thickness, the film thermal resistance is given by a film coefficient, h. The heat flow through a film is

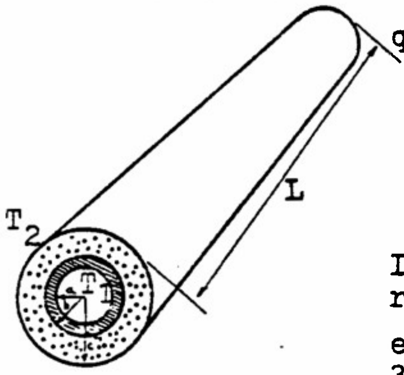
$$q = hA\Delta T \tag{3.9}$$

Table 3.3 (5:69)

Film Coefficients in BTU/hr-ft^2-°F	
No change in state	
air, still	1.65
air, with 15 mph wind	6.00
water	150 to 2000
other gases	3 to 50
gasoline, kerosene, alcohol and other organic solvents	60 to 500
oils	10 to 120
Condensing	
steam	1000 to 3000
organic solvents	150 to 500
light oils	200 to 400
heavy oils	20 to 50
ammonia	500 to 1000
Evaporating	
water	800 to 2000
organic solvents	100 to 300
light oils	150 to 300
heavy oils	10 to 50
ammonia	200 to 400
R-12	100 to 600

The commonly encountered insulated pipe with films can be solved by using equation 3.15, which requires all dimensions to be in feet.

Figure 3.2



$$q = \frac{2\pi L \Delta T}{\frac{1}{r_a h_a} + \frac{\ln(\frac{r_b}{r_a})}{k_{pipe}} + \frac{1}{r_b h_b} + \frac{\ln(\frac{r_c}{r_b})}{k_{insul.}} + \frac{1}{r_c h_c}} \qquad 3.15$$

If the wall and layers are very thin, or if the radii are large so that $A = A_a = A_c$, then the effects of curvature can be ignored and equation 3.10 can be used.

Example 3.2

Liquid oxygen at -290°F is stored in a 5' inside diameter, 20' long cylindrical stainless steel tank covered with 1 foot of powdered diatomaceous silica with average thermal conductivity of .022 BTU/ft-hr-°F. The environment temperature is 70°F and the wind is 15 mph. The tank walls are 3/8" thick. Compare the heat gain to the liquid oxygen using equations 3.15 and 3.10.

Required data:

material	t	k	h
stainless	.031	28.0	
silica	1.0	.022	
air, outside			6.0
oxygen, inside			∞

Equation 3.15 gives the exact solution as

$$q = \frac{2\pi(20)(70 + 290)}{\frac{\ln(\frac{2.53}{2.50})}{28.0} + \frac{\ln(\frac{3.53}{2.53})}{.022} + \frac{1}{(3.53)(6.0)}} = 2980 \text{ BTU/hr}$$

If the effects of curvature are ignored, equation 3.10 predicts the heat loss based on the outside area to be:

$$q = \frac{2\pi(3.53)(20)(70+290)}{\frac{.031}{28.0} + \frac{1.0}{.022} + \frac{1}{6}} = 3500 \text{ BTU/hr}$$

Since the addition of a covering (insulation) to a bare pipe also increases the surface area, adding insulation up to the critical thickness will actually increase the heat loss above bare-pipe levels. This critical radius is usually very small, and is most relevant in the cases of thin wires or capillaries. The critical radius is given by:

$$r_{critical} = \frac{k_{insulation}}{h} \qquad 3.16$$

A.5.H1-22

CONSTRUCTION COST ESTIMATE

Project: Repair Existing Steam Pipe & Fittings
Location: Pine Bluff Arsenal, AR
Basis: Schematic Design
ECO Number: H1-A

RS&H No.: 694-1331-004
Date: 6/27/96
Estimator: GWF
Filename: EST-H1A.XLS

ITEM DESCRIPTION		QUANTITY		MATERIAL/EQUIP		LABOR (1)		TOTAL COST	SOURCE	
		No.	Unit	$/Unit	Total	$/Unit	Total		Material	Labor
90° Elbows	1"	3	Ea	2.29	7	37	111	118	MMp145	MMp145
	2"	1	Ea	6.95	7	44	44	51	MMp145	MMp145
	6"	2	Ea	43	86	86	172	258	MMp158	MMp158
Gaskets	2"	2	Ea	4.87	10	37	74	84	MMp 157	MMp 157
Gage pig tail	1"	2	Ea	5	10	10	20	30	Estimate	Estimate
Piping	1"	8	LF	2.5	20	8.9	71	91	MMp 139	MMp 139
	2"	2	LF	4.49	9	13.5	27	36	MMp 139	MMp 139
Tees	1"	2	Ea	2.9	6	60	120	126	MMp 145	MMp 145
Steam Traps	1"	18	Ea	234	4,212	54	972	5,184	MMp 263	MMp 263
	2"	2	Ea	590	1,180	81	162	1,342	MMp 264	MMp 264
Unions	1"	1	Ea	28	28	30	30	58	MMp 157	MMp 157
Valves	1"	45	Ea	26	1,170	25.3	1,139	2,309	MMp 188	MMp 188
	2"	13	Ea	59.5	774	44	572	1,346	MMp 188	MMp 188
	3"	9	Ea	195	1,755	67	603	2,358	MMp 188	MMp 188
	4"	4	Ea	940	3,760	288	1,152	4,912	MMp 196	MMp 196
	6"	13	Ea	1475	19,175	448	5,824	24,999	MMp 196	MMp 196
Wyes	1"	1	Ea	13.25	13	30.3	30	43	MMp 271	MMp 271
Asbestos Abatement		128	Ea	11.5	1,472	46	5,888	7,360	MMp 24	MMp 24
Asbestos Disposal		6	CY	160	960	0	0	960	MMp 24	MMp 24
Insulation (2)		271	L.F.	4.06	1,100	3.16	856	1,956	MMp 239	MMp 239
Personnel hoist rental		2	Mo.	1450	2,900		0	2,900	MMp 15	MMp 15
Subtotal Bare Costs					38,654		17,867	56,521		
Retrofit Cost Factors				5%	1,933	9%	1,608	3,541	MMp6	MMp6
Subtotal					40,587		19,475	60,062		
City Cost Index				0.952	(1,948)	0.632	(7,167)	(9,115)	MMp533	MMp533
Subtotal					38,639		12,308	50,947		
OH & Profit Markups				10%	3,864	53%	6,523	10,387	MMp7	MMp475
Subtotal					42,503		18,831	61,334		
State Sales Taxes				4.5%	1,913		N.A.	1,913	MMp476	
Subtotal					44,416		18,831	63,247		
Contingency				10%	4,442	10%	1,883	6,325	MEp6	MEp6
Total Construction Cost					48,858		20,714	$69,572		
Design Fee					N.A.	6.0%	4,174	4,174		
SIOH					N.A.	6.0%	4,174	4,174		
Total Project Cost					48,858		29,062	$77,920		

LEGEND:

MEp###	1996 Means Electrical Cost Data, page ###.
MMp###	1996 Means Mechanical Cost Data, page ###.
Note (1)	Except for asbestos and insulation items, labor rates are doubled to cover cost for removal of existing material.
Note (2)	From Means, assumes 3 L.F. per fitting; uses cost for 4" diameter as an average.

ECO H1-A

PBA

Leak Survey

area	building	fitting	characterization	size	action
31	220/150	Trap	1	1	Replace
31	080	Valve	7	6	Replace
31	080	Valve	1	6	Replace
31	080	Valve	1	6	Replace
31	520	Valve	5	2	Replace
31	520	Trap	4	1	Replace
31	520	Gasket	4	2	Replace
31	529	Valve	2	1	Replace
31	530	Gasket	7	2	Replace
31	540	Valve	1	1	Replace
31	620	Valve	2	1	Replace
31	620	Trap	1	2	Replace
31	620	Valve	3	1	Replace
31	630	Valve	3	4	Replace
31	630	Valve	1	2	Replace

AG - WP Above ground tanks
IG - WP In-ground tanks
HL - High line

PBA

Leak Survey

ECO H1-A

area	building	fitting	characterization	size	action
32	trailers	Trap	3	1	Replace
32	060	Valve	3	1	Replace
32	060	Valve	2	6	Replace
32	060	Valve	1	6	Replace
32	169	Valve	1	1	Replace
32	440	Valve	1	1	Replace
32	516	Valve	2	2	Replace
32	520	Valve	2	3	Replace
32	520	Valve	1	1	Replace
32	529	Trap	5	2	Replace
32	530	Valve	1	6	Replace
32	530	Valve	2	1	Replace
32	530	Valve	3	2	Replace
32	540	Valve	6	1	Replace
32	610	Trap	3	1	Replace
32	619	Valve	4	3	Replace
32	620	Valve	4	2	Replace
32	631	Valve	3	2	Replace
32	639	Valve	5	1	Replace
32	640	Valve	1	2	Replace
32	640	Trap	2	1	Replace
32	720	elbow	7	1	Replace
32	720	Valve	3	1	Replace
32	720	Valve	5	1	Replace

AG - WP Above ground tanks
IG - WP In-ground tanks
HL - High line

ECO H1-A

PBA
Leak Survey

area	building	fitting	characterization	size	action
33	060	Valve	2	6	Replace
33	060	Valve	2	6	Replace
33	060	Valve	3	1	Replace
33	060	elbow	8	6	Replace
33	540	pipe	5	2	Replace
33	550	pipe	2	2	Replace
33	550	Valve	2	2	Replace
33	579	y	3	1	Replace
33	620	Valve	3	2	Replace
33	630	Valve	3	3	Replace
33	630	Valve	2	2	Replace
33	640	Valve	1	3	Replace
33	640	Valve	1	1	Replace
33	729	Valve	1	2	Replace

AG - WP Above ground tanks
IG - WP In-ground tanks
HL - High line

A.5.H1-26

ECO H1-A

PBA

Leak Survey

area	building	fitting	characterization	size	action
34	110	Valve	3	1	Replace
34	110	Valve	1	4	Replace
34	118	Valve	10	1	Replace
34	170	Valve	2	2	Replace
34	170	Valve	1	6	Replace
34	170	Valve	1	6	Replace
34	182	Valve	3	4	Replace
34	184	elbow	1	6	Replace
34	184	Valve	5	1	Replace
34	184	Valve	4	1	Replace
34	184	Valve	4	6	Replace
34	185	Valve	6	3	Replace
34	197	Valve	10	1	Replace
34	350	Valve	7	2	Replace
34	630	Valve	2	4	Replace
34	640	elbow	3	2	Replace
34	640	trap	1	1	Replace
34	640	union	4	1	Replace
34	640	Valve	1	1	Replace
34	650	Valve	2	1	Replace
34	660	Valve	1	1	Replace
34	660	Valve	2	1	Replace
34	660	Valve	3	1	Replace
34	AG	elbow		1	Replace
34	AG	pig tail		1	Replace
34	AG	pipe		1	Replace
34	AG	pipe		1	Replace
34	AG	pipe		1	Replace
34	AG	pipe		1	Replace
34	AG	T		1	Replace
34	AG	trap		1	Replace
34	AG	trap		1	Replace
34	AG	trap		1	Replace
34	AG	trap		1	Replace
34	AG	trap		1	Replace
34	AG	trap		1	Replace
34	AG	Valve		1	Replace
34	AG	Valve		1	Replace
34	AG	Valve		1	Replace
34	AG	Valve		1	Replace
34	AG	Valve		1	Replace
34	AG	Valve		1	Replace
34	AG	Valve		1	Replace
34	AG	Valve		1	Replace
34	AG	Valve		1	Replace
34	AG	Valve		3	Replace
34	AG	Valve		3	Replace
34	HL	Valve	1	1	Replace
34	HL	Valve	1	6	Replace
34	HL	Valve	1	6	Replace
34	IG	elbow	8	1	Replace

AG - WP Above ground tanks (not operating during survey, assume same as IG)
IG - WP In-ground tanks
HL - High line

ECO H1-A

area	building	fitting	characterization	size	action
32	720	elbow	7	1	Replace
34	IG	elbow	8	1	Replace
34	AG	elbow		1	Replace
34	640	elbow	3	2	Replace
33	060	elbow	8	6	Replace
34	184	elbow	1	6	Replace
31	520	Gasket	4	2	Replace
31	530	Gasket	7	2	Replace
34	IG	pig tail	6	1	Replace
34	AG	pig tail		1	Replace
34	IG	pipe	1	1	Replace
34	IG	pipe	7	1	Replace
34	IG	pipe	8	1	Replace
34	IG	pipe	8	1	Replace
34	AG	pipe		1	Replace
34	AG	pipe		1	Replace
34	AG	pipe		1	Replace
34	AG	pipe		1	Replace
33	540	pipe	5	2	Replace
33	550	pipe	2	2	Replace
34	IG	T	3	1	Replace
34	AG	T		1	Replace
31	520	Trap	4	1	Replace
31	220/150	Trap	1	1	Replace
32	610	Trap	3	1	Replace
32	640	Trap	2	1	Replace
32	trailers	Trap	3	1	Replace
34	640	trap	1	1	Replace
34	IG	trap	1	1	Replace
34	IG	trap	1	1	Replace
34	IG	trap	1	1	Replace
34	IG	trap	8	1	Replace
34	IG	trap	3	1	Replace
34	IG	trap	3	1	Replace
34	AG	trap		1	Replace
34	AG	trap		1	Replace
34	AG	trap		1	Replace
34	AG	trap		1	Replace
34	AG	trap		1	Replace
34	AG	trap		1	Replace
31	620	Trap	1	2	Replace
32	529	Trap	5	2	Replace
34	640	union	4	1	Replace
31	529	Valve	2	1	Replace
31	540	Valve	1	1	Replace
31	620	Valve	2	1	Replace
31	620	Valve	3	1	Replace
32	169	Valve	1	1	Replace
32	440	Valve	1	1	Replace
32	520	Valve	1	1	Replace
32	530	Valve	2	1	Replace
32	540	Valve	6	1	Replace
32	639	Valve	5	1	Replace
32	720	Valve	3	1	Replace
32	720	Valve	5	1	Replace
32	060	Valve	3	1	Replace
33	640	Valve	1	1	Replace
33	060	Valve	3	1	Replace
34	110	Valve	3	1	Replace
34	118	Valve	10	1	Replace

AG-WP Above ground tanks
IG - WP In-ground str'g tanks
HL - High line

A.5.H1-28

ECO H1-A

area	building	fitting	characterization	size	action
34	184	Valve	5	1	Replace
34	184	Valve	4	1	Replace
34	197	Valve	10	1	Replace
34	640	Valve	1	1	Replace
34	650	Valve	2	1	Replace
34	660	Valve	1	1	Replace
34	660	Valve	2	1	Replace
34	660	Valve	3	1	Replace
34	HL	Valve	1	1	Replace
34	IG	Valve	5	1	Replace
34	IG	Valve	1	1	Replace
34	IG	Valve	3	1	Replace
34	IG	Valve	6	1	Replace
34	IG	Valve	4	1	Replace
34	IG	Valve	3	1	Replace
34	IG	Valve	9	1	Replace
34	IG	Valve	3	1	Replace
34	IG	Valve	2	1	Replace
34	slag pit	Valve	8	1	Replace
34	AG	Valve		1	Replace
34	AG	Valve		1	Replace
34	AG	Valve		1	Replace
34	AG	Valve		1	Replace
34	AG	Valve		1	Replace
34	AG	Valve		1	Replace
34	AG	Valve		1	Replace
34	AG	Valve		1	Replace
34	AG	Valve		1	Replace
31	520	Valve	5	2	Replace
31	630	Valve	1	2	Replace
32	516	Valve	2	2	Replace
32	530	Valve	3	2	Replace
32	620	Valve	4	2	Replace
32	631	Valve	3	2	Replace
32	640	Valve	1	2	Replace
33	550	Valve	2	2	Replace
33	620	Valve	3	2	Replace
33	630	Valve	2	2	Replace
33	729	Valve	1	2	Replace
34	170	Valve	2	2	Replace
34	350	Valve	7	2	Replace
32	520	Valve	2	3	Replace
32	619	Valve	4	3	Replace
33	630	Valve	3	3	Replace
33	640	Valve	1	3	Replace
34	185	Valve	6	3	Replace
34	IG	Valve	6	3	Replace
34	IG	Valve	1	3	Replace
34	AG	Valve		3	Replace
34	AG	Valve		3	Replace
31	630	Valve	3	4	Replace
34	110	Valve	1	4	Replace
34	182	Valve	3	4	Replace
34	630	Valve	2	4	Replace
31	080	Valve	7	6	Replace
31	080	Valve	1	6	Replace
31	080	Valve	1	6	Replace

AG-WP Above ground tanks
IG - WP In-ground str'g tanks
HL - High line

ECO H1-A

Sort size

area	building	fitting	characterization	size	action
32	720	elbow	7	1	Replace
34	IG	elbow	8	1	Replace
34	AG	elbow		1	Replace
34	IG	pig tail	6	1	Replace
34	AG	pig tail		1	Replace
34	IG	pipe	1	1	Replace
34	IG	pipe	7	1	Replace
34	IG	pipe	8	1	Replace
34	IG	pipe	8	1	Replace
34	AG	pipe		1	Replace
34	AG	pipe		1	Replace
34	AG	pipe		1	Replace
34	AG	pipe		1	Replace
34	IG	T	3	1	Replace
34	AG	T		1	Replace
31	520	Trap	4	1	Replace
31	220/150	Trap	1	1	Replace
32	610	Trap	3	1	Replace
32	640	Trap	2	1	Replace
32	trailers	Trap	3	1	Replace
34	640	trap	1	1	Replace
34	IG	trap	1	1	Replace
34	IG	trap	1	1	Replace
34	IG	trap	1	1	Replace
34	IG	trap	8	1	Replace
34	IG	trap	3	1	Replace
34	IG	trap	3	1	Replace
34	AG	trap		1	Replace
34	AG	trap		1	Replace
34	AG	trap		1	Replace
34	AG	trap		1	Replace
34	AG	trap		1	Replace
34	AG	trap		1	Replace
34	640	union	4	1	Replace
31	529	Valve	2	1	Replace
31	540	Valve	1	1	Replace
31	620	Valve	2	1	Replace
31	620	Valve	3	1	Replace
32	169	Valve	1	1	Replace
32	440	Valve	1	1	Replace
32	520	Valve	1	1	Replace
32	530	Valve	2	1	Replace
32	540	Valve	6	1	Replace
32	639	Valve	5	1	Replace
32	720	Valve	3	1	Replace
32	720	Valve	5	1	Replace
32	060	Valve	3	1	Replace
33	640	Valve	1	1	Replace
33	060	Valve	3	1	Replace
34	110	Valve	3	1	Replace

AG - WP above ground tanks
IG - WP in-ground tanks
HL - High line

ECO H1-A

Sort size

area	building	fitting	characterization	size	action
34	118	Valve	10	1	Replace
34	184	Valve	5	1	Replace
34	184	Valve	4	1	Replace
34	197	Valve	10	1	Replace
34	640	Valve	1	1	Replace
34	650	Valve	2	1	Replace
34	660	Valve	1	1	Replace
34	660	Valve	2	1	Replace
34	660	Valve	3	1	Replace
34	HL	Valve	1	1	Replace
34	IG	Valve	5	1	Replace
34	IG	Valve	1	1	Replace
34	IG	Valve	3	1	Replace
34	IG	Valve	6	1	Replace
34	IG	Valve	4	1	Replace
34	IG	Valve	3	1	Replace
34	IG	Valve	9	1	Replace
34	IG	Valve	3	1	Replace
34	IG	Valve	2	1	Replace
34	slag pit	Valve	8	1	Replace
34	AG	Valve		1	Replace
34	AG	Valve		1	Replace
34	AG	Valve		1	Replace
34	AG	Valve		1	Replace
34	AG	Valve		1	Replace
34	AG	Valve		1	Replace
34	AG	Valve		1	Replace
34	AG	Valve		1	Replace
34	AG	Valve		1	Replace
33	579	y	3	1	Replace
34	640	elbow	3	2	Replace
31	520	Gasket	4	2	Replace
31	530	Gasket	7	2	Replace
33	540	pipe	5	2	Replace
33	550	pipe	2	2	Replace
31	620	Trap	1	2	Replace
32	529	Trap	5	2	Replace
31	520	Valve	5	2	Replace
31	630	Valve	1	2	Replace
32	516	Valve	2	2	Replace
32	530	Valve	3	2	Replace
32	620	Valve	4	2	Replace
32	631	Valve	3	2	Replace
32	640	Valve	1	2	Replace
33	550	Valve	2	2	Replace
33	620	Valve	3	2	Replace
33	630	Valve	2	2	Replace
33	729	Valve	1	2	Replace
34	170	Valve	2	2	Replace
34	350	Valve	7	2	Replace

AG - WP above ground tanks
IG - WP in-ground tanks
HL - High line

A.5.H1-31

ECO H1-A

Sort size

area	building	fitting	characterization	size	action
32	520	Valve	2	3	Replace
32	619	Valve	4	3	Replace
33	630	Valve	3	3	Replace
33	640	Valve	1	3	Replace
34	185	Valve	6	3	Replace
34	IG	Valve	6	3	Replace
34	IG	Valve	1	3	Replace
34	AG	Valve		3	Replace
34	AG	Valve		3	Replace
31	630	Valve	3	4	Replace
34	110	Valve	1	4	Replace
34	182	Valve	3	4	Replace
34	630	Valve	2	4	Replace
33	060	elbow	8	6	Replace
34	184	elbow	1	6	Replace
31	080	Valve	7	6	Replace
31	080	Valve	1	6	Replace
31	080	Valve	1	6	Replace
32	530	Valve	1	6	Replace
32	060	Valve	2	6	Replace
32	060	Valve	1	6	Replace
33	060	Valve	2	6	Replace
33	060	Valve	2	6	Replace
34	170	Valve	1	6	Replace
34	170	Valve	1	6	Replace
34	184	Valve	4	6	Replace
34	HL	Valve	1	6	Replace
34	HL	Valve	1	6	Replace
size	thkness	area	No	CY	
1	2	0.5	80	1	
2	2	1	40	1	
3	2	1.5	27	1	
4	2	2	16	1	
6	2	2.5	90	2	
				6	

AG - WP above ground tanks
IG - WP in-ground tanks
HL - High line

A.5.H1-32

CONSTRUCTION COST ESTIMATE

Project:	Install new steam distribution system	RS&H No.:	694-1331-004
Location:	Pine Bluff Arsenal, AR	Date:	6/26/96
Basis:	Schematic Design	Estimator:	GWF
ECO Number:	H1-B	Filename:	EST-H1B.XLS

ITEM DESCRIPTION	QUANTITY		MATERIAL/EQUIP		LABOR		TOTAL COST	SOURCE	
	No.	Unit	$/Unit	Total	$/Unit	Total		Material	Labor
Pipe and Hangers									
2 " Dia.	13980	L.F.	4.49	62,770	6.75	94,365	157,135	MMp 139	MMp 139
3 " Dia.	3780	L.F.	9.05	34,209	10.05	37,989	72,198	MMp 139	MMp 139
4 " Dia.	6500	L.F.	13.2	85,800	12	78,000	163,800	MMp 139	MMp 139
6 " Dia.	19220	L.F.	23	442,060	21.5	413,230	855,290	MMp 139	MMp 139
Traps - 1" Dia	2118	ea	234	495,612	27	57,186	552,798	MMp 263	MMp 263
Valves									
1 " Dia.	4236	ea	26	110,136	12.65	53,585	163,721	MMp 188	MMp 188
2 " Dia.	114	ea	59.5	6,783	22	2,508	9,291	MMp 188	MMp 188
3 " Dia.	8	ea	195	1,560	33.5	268	1,828	MMp 188	MMp 188
4 " Dia.	14	ea	940	13,160	144	2,016	15,176	MMp 196	MMp 196
6 " Dia.	15	ea	1475	22,125	224	3,360	25,485	MMp 196	MMp 196
Elbows									
2 " Dia.	289	ea	6.95	2,009	24	6,936	8,945	MMp145	MMp145
3 " Dia.	80	ea	26	2,080	43.5	3,480	5,560	MMp145	MMp145
4 " Dia.	112	ea	17.5	1,960	97	10,864	12,824	MMp158	MMp158
6 " Dia.	176	ea	43	7,568	145.5	25,608	33,176	MMp158	MMp158
T's									
2 " Dia.	35	ea	9.8	343	39.5	1,383	1,726	MMp145	MMp145
3 " Dia.	13	ea	37	481	72	936	1,417	MMp145	MMp145
4 " Dia.	25	ea	32	800	161.55	4,039	4,839	MMp158	MMp158
6 " Dia.	36	ea	59	2,124	241.5	8,694	10,818	MMp158	MMp158
Insulation									
2 " Dia.	13980	L.F.	3.05	42,639	2.28	31,874	74,513	MMp 239	MMp 239
3 " Dia.	3780	L.F.	3.53	13,343	2.57	9,715	23,058	MMp 239	MMp 239
4 " Dia.	6500	L.F.	4.06	26,390	3.16	20,540	46,930	MMp 239	MMp 239
6 " Dia.	19220	L.F.	4.71	90,526	4.11	78,994	169,520	MMp 239	MMp 239
Fittings	21813	L.F.	4.06	88,561	3.16	68,929	157,490	MMp 239	MMp 239
Jacket 0.010" Alum.									
2 " Dia.	7320	SF	0.42	3,074	3.43	25,107	28,181	MMp 239	MMp 239
3 " Dia.	2969	SF	0.42	1,247	3.43	10,183	11,430	MMp 239	MMp 239
4 " Dia.	6807	SF	0.42	2,859	3.43	23,347	26,206	MMp 239	MMp 239
6 " Dia.	30191	SF	0.42	12,680	3.43	103,554	116,234	MMp 239	MMp 239
Pipe Support Brackets	961	Ea	107	102,827	7.05	6,775	109,602	MMp 179	MMp 179
Subtotal New Piping				1,675,726		1,183,465	2,859,191		

LEGEND:

MEp###	1996 Means Electrical Cost Data, page ###.
MMp###	1996 Means Mechanical Cost Data, page ###.

CONSTRUCTION COST ESTIMATE

Project:	Install new steam distribution system	RS&H No.:	694-1331-004
Location:	Pine Bluff Arsenal, AR	Date:	6/26/96
Basis:	Schematic Design	Estimator:	GWF
ECO Number:	H1-B	Filename:	EST-H1B.XLS

ITEM DESCRIPTION	QUANTITY		MATERIAL/EQUIP		LABOR		TOTAL COST	SOURCE	
	No.	Unit	$/Unit	Total	$/Unit	Total		Material	Labor
Asbestos ins. removal - pipe									
2 " Dia.	13980	L.F.	7.95	111,141	18.30	255,834	366,975	MMp 24	MMp 24
3 " Dia.	3780	L.F.	7.95	30,051	18.30	69,174	99,225	MMp 24	MMp 24
4 " Dia.	6500	L.F.	7.95	51,675	18.30	118,950	170,625	MMp 24	MMp 24
6 " Dia.	19220	L.F.	7.95	152,799	18.30	351,726	504,525	MMp 24	MMp 24
Asbestos removal - fittings	5153	Ea	11.50	59,260	46.00	237,038	296,298	MMp 24	MMp 24
Asbestos Disposal - pipe	394	CY	160.00	62,987		0	62,987	MMp 24	
Asbestos Disposal - fittings.	22	CY	161.00	3,555		0	3,555	MMp 24	
Piping Demolition									
2 " Dia.	13980	L.F.		0	1.2	16,776	16,776	MMp 22	MMp 22
3 " Dia.	3780	L.F.		0	1.4	5,292	5,292	MMp 22	MMp 22
4 " Dia.	6500	L.F.		0	1.6	10,400	10,400	MMp 22	MMp 22
6 " Dia.	19220	L.F.		0	3.2	61,504	61,504	MMp 22	MMp 22
Subtotal Demolition				471,468		1,126,694	1,598,162		
Subtotal New Piping				1,675,726		1,183,465	2,859,191		
Subtotal Bare Costs				2,147,194		2,310,159	4,457,353		
Retrofit Cost Factors			0%	0	0%	0	0	MMp6	MMp6
Subtotal				2,147,194		2,310,159	4,457,353		
City Cost Index			0.952	(103,065)	0.632	(850,139)	(953,204)	MMp533	MMp533
Subtotal				2,044,129		1,460,020	3,504,149		
OH & Profit Markups			10%	204,413	53%	773,811	978,224	MMp7	MMp475
Subtotal				2,248,542		2,233,831	4,482,373		
State Sales Taxes			4.5%	101,184		N.A.	101,184	MMp476	
Subtotal				2,349,726		2,233,831	4,583,557		
Contingency			10%	234,973	10%	223,383	458,356	MEp6	MEp6
Total Construction Cost				2,584,699		2,457,214	**$5,041,913**		
Design Fee				N.A.	6.0%	302,515	302,515		
SIOH				N.A.	6.0%	302,515	302,515		
Total Project Cost				2,584,699		3,062,244	**$5,646,943**		

LEGEND:

MEp### 1996 Means Electrical Cost Data, page ###.

MMp### 1996 Means Mechanical Cost Data, page ###.

A.5.H1-34

ECO H1-B

Pipe

Pipe Size (in)			2		3		4		6	
Area	Leg	Association	Loops	Length	Loops	Length	Loops	Length	Loops	Length
31	South	Expansion Loops @ 20' ea	4	80	4	80	0	0	0	0
		Road Loops @ 30' ea	4	120	2	60	1	30	2	60
		Strait		1500		900		400		550
31	North	Expansion Loops @ 20' ea	2	40	4	80	0	0	0	0
		Road Loops @ 30' ea	6	180	2	60	1	30	1	30
		Strait		3600		700		400		500
32	South	Expansion Loops @ 20' ea	2	40	1	20	3	60	2	40
		Road Loops @ 30' ea	5	150	1	30	1	30	2	60
		Strait		1750		450		450		900
32	North	Expansion Loops @ 20' ea	4	80	1	20	2	40	1	20
		Road Loops @ 30' ea	4	120	1	30	2	60	1	30
		Strait		1800		400		800		550
33	South	Expansion Loops @ 20' ea	4	80	2	40	3	60	1	20
		Road Loops @ 30' ea	4	120	1	30	2	60	1	30
		Strait		1300		450		850		550
33	North	Expansion Loops @ 20' ea	2	40	0	0	1	20	1	20
		Road Loops @ 30' ea	2	60	1	30	2	60	1	30
		Strait		1600		400		800		550
34	South	Expansion Loops @ 20' ea	0	0	0	0	5	100	2	40
		Road Loops @ 30' ea	1	30	0	0	5	150	1	30
		Strait		300		0		2100		1200
34	North	Expansion Loops @ 20' ea	2	40	0	0	0	0	3	60
		Road Loops @ 30' ea	0	0	0	0	0	0	0	0
		Strait		950						2350
All	High Line	Expansion Loops @ 20' ea		0		0		0	25	500
		Road Loops @ 30' ea		0		0		0	0	0
		Strait								11100
Total				13980		3780		6500		19220

ECO H1-B

1 inch dia. Steam Traps				
Area	Leg	road loops	terminations	traps
31	South	309	13	322
31	North	340	9	349
32	South	309	11	320
32	North	278	13	291
33	South	278	13	291
33	North	216	10	226
34	South	247	6	253
34	North	30	13	43
	High Line	0	0	23
Total		2007	88	2118

ECO H1-B

valves

			Pipe Size (in)				
Area	Leg	Association	1	2	3	4	6
31	South	Road Loops @ 1 ea		4	2	1	2
		traps @ 2 ea	644				
		Terminations		13			
31	North	Road Loops @ 1 ea		6	2	1	1
		traps @ 2 ea	698				
		Terminations		9			
32	South	Road Loops @ 1 ea		5	1	1	2
		traps @ 2 ea	640				
		Terminations		11			
32	North	Road Loops @ 1 ea		4	1	2	1
		traps @ 2 ea	582				
		Terminations		13			
33	South	Road Loops @ 1 ea		4	1	2	1
		traps @ 2 ea	582				
		Terminations		13			
33	North	Road Loops @ 1 ea		2	1	2	1
		traps @ 2 ea	452				
		Terminations		10			
34	South	Road Loops @ 1 ea		1	0	5	1
		traps @ 2 ea	506				
		Terminations		6			
34	North	Road Loops @ 1 ea		0	0	0	0
		traps @ 2 ea	86				
		Terminations		13			
	High Line	Road Loops @ 1 ea		0	0	0	0
		traps @ 2 ea	46				
		Terminations					
		Total	4236	114	8	14	15

ECO H1-B

Pipe Size (in)			2		3		4		6	
Area	Leg	Association	Loops	Els	Loops	Els	Loops	Els	Loops	Els
31	South	Expansion Loops @ 4 ea	4	16	4	16	0	0	0	0
		Road Loops @ 4 ea	4	16	2	8	1	4	2	8
		Route		40		0		0		0
31	North	Expansion Loops @ 4 ea	2	8	4	16	0	0	0	0
		Road Loops @ 4 ea	6	24	2	8	1	4	1	4
		Route		1		0		0		0
32	South	Expansion Loops @ 4 ea	2	8	1	4	3	12	2	8
		Road Loops @ 4 ea	5	20	1	4	1	4	2	8
		Route		3		0		0		0
32	North	Expansion Loops @ 4 ea	4	16	1	4	2	8	1	4
		Road Loops @ 4 ea	4	16	1	4	2	8	1	4
		Route		10		0		0		0
33	South	Expansion Loops @ 4 ea	4	16	2	8	3	12	1	4
		Road Loops @ 4 ea	4	16	1	4	2	8	1	4
		Route		5		0		0		0
33	North	Expansion Loops @ 4 ea	2	8	0	0	1	4	1	4
		Road Loops @ 4 ea	2	8	1	4	2	8	1	4
		Route		6		0		0		0
34	South	Expansion Loops @ 4 ea	0	0	0	0	5	20	2	8
		Road Loops @ 4 ea	1	4	0	0	5	20	1	4
		Route		10		0		0		0
34	North	Expansion Loops @ 4 ea	2	8	0	0	0	0	3	12
		Road Loops @ 4 ea	0	0	0	0	0	0	0	0
		Route		30						0
	High Line	Expansion Loops @ 4 ea		0		0		0	25	100
		Road Loops @ 4 ea		0		0		0	0	0
		Route								0
		Total		289		80		112		176

T's

Pipe T's					
Area	Leg	Pipe Size (in.)			
		2	3	4	6
31	South	3	4	3	0
31	North	1	3	2	2
32	South	1	2	4	2
32	North	2	1	3	5
33	South	17	1	2	1
33	North	11	2	6	2
34	South	0	0	5	1
34	North	0	0	0	12
	High Line	0	0	0	11
Total		35	13	25	36

ECO H1-B

asbestos

Pipe dia	Insul. thkness	insul o.d.	box length	lengths on bottom	lengths on side	length of length	total length in box	total length of pipe	total CY
2	2	4	36	9	9	3	243	13980	58
3	2	5	36	8	8	3	192	3780	20
4	2	6	36	6	6	3	108	6500	60
6	2	8	36	5	5	3	75	19220	256
									394

fittings	Insul. thkness	SF per fitting	No. of Fittings	Cubic Yards
1	2	0.5	4236	13
2	2	1	438	3
3	2	1.5	101	1
4	2	2	151	2
6	2	2.5	227	4
		Totals	5153	22

ECO-H2

Modifications and improvements to boilers in Building 32-060.

Option A - Install new boilers with turbulators, O_2 trim, economizers, etc.

Option B - Improve efficiency of existing boilers.

Option C - Install surplus boilers and add economizers.

Option D - Install economizers on surplus boilers.

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: ECO-H2
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID FY95 (92)
INSTALLATION & LOCATION: P B ARSENAL REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: ECO-H2 BOILER MODIFICATIONS IN BUILDING 32-060
FISCAL YEAR 1997 DISCRETE PORTION NAME: OPTION A - NEW BOILERS
ANALYSIS DATE: 07-01-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

A. CONSTRUCTION COST	$ 581838.		
B. SIOH	$ 34911.		
C. DESIGN COST	$ 34911.		
D. TOTAL COST (1A+1B+1C)	$ 651660.		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F. PUBLIC UTILITY COMPANY REBATE		$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 651660.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 16.79	0.	$ 0.	15.08	$ 0.
B. DIST	$ .00	0.	$ 0.	18.57	$ 0.
C. RESID	$ .00	0.	$ 0.	21.02	$ 0.
D. NAT G	$ 2.81	12914.	$ 36288.	18.58	$ 674237.
E. COAL	$ .00	0.	$ 0.	16.83	$ 0.
F. PPG	$ .00	0.	$ 0.	17.38	$ 0.
M. DEMAND SAVINGS			$ 0.	14.88	$ 0.
N. TOTAL		12914.	$ 36288.		$ 674237.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)		$ 8320.
(1) DISCOUNT FACTOR (TABLE A)	14.88	
(2) DISCOUNTED SAVING/COST (3A X 3A1)		$ 123802.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ 123802.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 44608.

5. SIMPLE PAYBACK PERIOD (1G/4) 14.61 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 798039.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 1.22
(IF < 1 PROJECT DOES NOT QUALIFY)

A.5.H2-2 9/96

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-H2
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: P B ARSENAL REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: ECO-H2 BOILER MODIFICATIONS IN BUILDING 32-060
FISCAL YEAR 1997 DISCRETE PORTION NAME: OPTION B - FUEL/AIR CONTROLS
ANALYSIS DATE: 07-01-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

A. CONSTRUCTION COST	$ 6378.			
B. SIOH	$ 383.			
C. DESIGN COST	$ 383.			
D. TOTAL COST (1A+1B+1C)	$ 7144.			
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.		
F. PUBLIC UTILITY COMPANY REBATE		$ 0.		
G. TOTAL INVESTMENT (1D - 1E - 1F)			$	7144.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 16.79	0.	$ 0.	15.08	$ 0.
B. DIST	$ .00	0.	$ 0.	18.57	$ 0.
C. RESID	$ .00	0.	$ 0.	21.02	$ 0.
D. NAT G	$ 2.81	6457.	$ 18144.	18.58	$ 337119.
E. COAL	$ .00	0.	$ 0.	16.83	$ 0.
F. PPG	$ .00	0.	$ 0.	17.38	$ 0.
M. DEMAND SAVINGS			$ 0.	14.88	$ 0.
N. TOTAL		6457.	$ 18144.		$ 337119.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)		$ 0.
(1) DISCOUNT FACTOR (TABLE A)	14.88	
(2) DISCOUNTED SAVING/COST (3A X 3A1)		$ 0.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 0.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 18144.

5. SIMPLE PAYBACK PERIOD (1G/4) .39 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 337119.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 47.19
(IF < 1 PROJECT DOES NOT QUALIFY)

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: ECO-H2
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID FY95 (92)
INSTALLATION & LOCATION: P B ARSENAL REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: ECO-H2 BOILER MODIFICATIONS IN BUILDING 32-060
FISCAL YEAR 1997 DISCRETE PORTION NAME: OPTION C - SURPLUS BOILERS
ANALYSIS DATE: 07-01-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

A. CONSTRUCTION COST	$ 266165.		
B. SIOH	$ 15970.		
C. DESIGN COST	$ 15970.		
D. TOTAL COST (1A+1B+1C)	$ 298105.		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F. PUBLIC UTILITY COMPANY REBATE		$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 298105.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 16.79	0.	$ 0.	15.08	$ 0.
B. DIST	$ .00	0.	$ 0.	18.57	$ 0.
C. RESID	$ .00	0.	$ 0.	21.02	$ 0.
D. NAT G	$ 2.81	12914.	$ 36288.	18.58	$ 674237.
E. COAL	$ .00	0.	$ 0.	16.83	$ 0.
F. PPG	$ .00	0.	$ 0.	17.38	$ 0.
M. DEMAND SAVINGS			$ 0.	14.88	$ 0.
N. TOTAL		12914.	$ 36288.		$ 674237.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) — $ 8320.
(1) DISCOUNT FACTOR (TABLE A) — 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) — $ 123802.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 123802.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 44608.

5. SIMPLE PAYBACK PERIOD (1G/4) 6.68 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 798039.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 2.68
(IF < 1 PROJECT DOES NOT QUALIFY)

A.5.H2-4 9/96

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: ECO-H2
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID FY95 (92)

INSTALLATION & LOCATION: P B ARSENAL REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: ECO-H2 BOILER MODIFICATIONS IN BUILDING 32-060
FISCAL YEAR 1997 DISCRETE PORTION NAME: OPTION D - INSTALL ECONOMIZERS
ANALYSIS DATE: 08-22-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

A. CONSTRUCTION COST	$ 76612.		
B. SIOH	$ 4597.		
C. DESIGN COST	$ 4597.		
D. TOTAL COST (1A+1B+1C)	$ 85806.		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F. PUBLIC UTILITY COMPANY REBATE		$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 85806.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 16.79	0.	$ 0.	15.08	$ 0.
B. DIST	$ .00	0.	$ 0.	18.57	$ 0.
C. RESID	$ .00	0.	$ 0.	21.02	$ 0.
D. NAT G	$ 2.81	5381.	$ 15121.	18.58	$ 280941.
E. COAL	$ .00	0.	$ 0.	16.83	$ 0.
F. PPG	$ .00	0.	$ 0.	17.38	$ 0.
M. DEMAND SAVINGS			$ 0.	14.88	$ 0.
N. TOTAL		5381.	$ 15121.		$ 280941.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 0.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 15121.

5. SIMPLE PAYBACK PERIOD (1G/4) 5.67 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 280941.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 3.27
(IF < 1 PROJECT DOES NOT QUALIFY)

A.5.H2-5 9/96

Pine Bluff Arsenal

Energy Savings Calculations

ECO Number:	H2A	
		Notes
Building Number:	32-060	
Natural Gas consumption (MBtu/Yr):	107,613	(1)
Current Boiler Efficiency:	0.74	(2)
New/Improved Boiler Efficiency:	0.86	(3)

Notes:

(1) Assumes steam leaks are repaired, see attached calculation sheet.
(2) Actual efficiency calculated from field measurements.
(3) Efficiency of a new or properly operating boiler with an economizer.

Energy Savings = (Improved efficiency - Current efficiency) x Natural gas consumption

= (0.86 - 0.74) x 107,613 MBtu/yr

Energy Savings = 12,914 MBtu/yr

CONSTRUCTION COST ESTIMATE

Project:	Modifications & Improvements to boilers in Bldg.32-060	RS&H No.:	694-1331-004
Location:	Pine Bluff Arsenal, AR	Date:	6/27/96
Basis:	Schematic Design	Estimator:	GWF
ECO Number:	H2-A: Install new boilers w/ turbulators, O_2 Trim, economizers, etc.	Filename:	EST-H2A.XLS

ITEM DESCRIPTION	QUANTITY		MATERIAL/EQUIP		LABOR		TOTAL COST	SOURCE	
	No.	Unit	$/Unit	Total	$/Unit	Total		Material	Labor
Fire tube boiler - 25,000mbh	2	ea	107974	215,949	32596.1	65,192	$ 281,141	MMp 213	MMp 213
125 psig, gas & No.2 oil,									
Peripheral equip. for boiler;	2	ea	26993.6	53,987	8149.01	16,298	$ 70,285	Use 25%	Use 25%
piping, pumps, deaerator,									
water treatment, etc.									
Economizer	2	ea	18000	36,000	5000	10,000	$ 46,000	Vendor	Vendor
Stack (50 ft each x 2)	100	L.F.	139	13,900	21.5	2,150	$ 16,050	MMp 246	MMp 246
O_2 Trim controls	2	ea	2555	5,110		0	$ 5,110	MMp 318	
Demolition ductwork	40	L.F.		0	2.99	120	$ 120		MMp 20
Demolition boilers (2)	88	ton		0	395	34,614	$ 34,614		MMp 20
Bulk Asbestos Removal	2000	SF	0.69	1,380	5.72	11,430	$ 12,810	MMp 23	MMp 23
Collect and bag asbes.	220	Bag	1.2	264	4.58	1,008	$ 1,272	MMp 24	MMp 24
Containerize full bags	220	Ea	2.42	532	2.29	504	$ 1,036	MMp 24	MMp 24
Asbes. disposal charges	24	CY		0	160	3,911	$ 3,911		MMp 24
Subtotal Bare Costs				327,122		145,227	472,349		
Retrofit Cost Factors			5%	16,356	9%	13,070	29,426	MMp6	MMp6
Subtotal				343,478		158,297	501,775		
City Cost Index			0.952	(16,487)	0.632	(58,253)	(74,740)	MMp533	MMp533
Subtotal				326,991		100,044	427,035		
OH & Profit Markups			10%	32,699	53%	53,023	85,722	MMp7	MMp475
Subtotal				359,690		153,067	512,757		
State Sales Taxes			4.5%	16,186		N.A.	16,186	MMp476	
Subtotal				375,876		153,067	528,943		
Contingency			10%	37,588	10%	15,307	52,895	MEp6	MEp6
Total Construction Cost				**413,464**		**168,374**	**$581,838**		
Design Fee				N.A.	6.0%	34,910	34,910		
SIOH				N.A.	6.0%	34,910	34,910		
Total Project Cost				**413,464**		**238,194**	**$651,658**		

LEGEND:

MEp###	1996 Means Electrical Cost Data, page ###.
MMp###	1996 Means Mechanical Cost Data, page ###.
Vendor	Vendor estimate, see attached telephone call confirmation.

9/96

A.5.H2-7

Pine Bluff Arsenal

Energy Savings Calculations

ECO Number:	H2B	
		Notes
Building Number:	32-060	
Natural Gas consumption (MBtu/Yr):	107,613	(1)
Current Boiler Efficiency:	0.74	(2)
New/Improved Boiler Efficiency:	0.80	(3)

Notes:

(1) Assumes steam leaks are repaired, see attached calculation sheet.
(2) Actual efficiency calculated from field measurements.
(3) Efficiency of a new or properly operating boiler.

Energy Savings = (Improved efficiency - Current efficiency) x Natural gas consumption

= (0.80 - 0.74) x 107,613 MBtu/yr

Energy Savings = 6,457 MBtu/yr

CONSTRUCTION COST ESTIMATE

Project:	Modifications & Improvements to boilers in Bldg.32-060	RS&H No.:	694-1331-004
Location:	Pine Bluff Arsenal, AR	Date:	6/26/96
Basis:	Schematic Design	Estimator:	GWF
ECO Number:	H2-B: Improve efficiency of existing boilers	Filename:	EST-H2B.XLS

ITEM DESCRIPTION	QUANTITY		MATERIAL/EQUIP		LABOR		TOTAL COST	SOURCE	
	No.	Unit	$/Unit	Total	$/Unit	Total		Material	Labor
Jackshaft cam kit for boiler	2	Ea	527.82	1,056	2400	4,800	5,856	Vendor	Est. (1)
Subtotal Bare Costs				1,056		4,800	5,856		
Retrofit Cost Factors			0%	0	0%	0	0	MMp6	MMp6
Subtotal				1,056		4,800	5,856		
City Cost Index			0.952	(51)	0.632	(1,766)	(1,817)	MMp533	MMp533
Subtotal				1,005		3,034	4,039		
OH & Profit Markups			10%	101	53%	1,608	1,709	MMp7	MMp475
Subtotal				1,106		4,642	5,748		
State Sales Taxes			4.5%	50		N.A.	50	MMp476	
Subtotal				1,156		4,642	5,798		
Contingency			10%	116	10%	464	580	MEp6	MEp6
Total Construction Cost				**1,272**		**5,106**	**$6,378**		
Design Fee				N.A.	6.0%	383	383		
SIOH				N.A.	6.0%	383	383		
Total Project Cost				**1,272**		**5,872**	**$7,144**		

LEGEND:

Note (1)	Assumes 3 days to install, $800 per day for labor and expenses.
MEp###	1996 Means Electrical Cost Data, page ###.
MMp###	1996 Means Mechanical Cost Data, page ###.
Vendor	Vendor quote, see attached fax.

Pine Bluff Arsenal

Energy Savings Calculations

ECO Number:	H2C	
		Notes
Building Number:	32-060	
Natural Gas consumption (MBtu/Yr):	107,613	(1)
Current Boiler Efficiency:	0.74	(2)
New/Improved Boiler Efficiency:	0.86	(3)

Notes:

(1) Assumes steam leaks are repaired, see attached calculation sheet.
(2) Actual efficiency calculated from field measurements.
(3) Efficiency of a new or properly operating boiler with an economizer.

Energy Savings = (Improved efficiency - Current efficiency) x Natural gas consumption

= (0.86 - 0.74) x 107,613 MBtu/yr

Energy Savings = 12,914 MBtu/yr

CONSTRUCTION COST ESTIMATE

Project: Modifications & Improvements to boilers in Bldg.32-060
Location: Pine Bluff Arsenal, AR
Basis: Schematic Design
ECO Number: H2-C: Install surplus boilers w/ economizers

RS&H No.: 694-1331-004
Date: 6/27/96
Estimator: GWF
Filename: EST-H2C.XLS

ITEM DESCRIPTION	QUANTITY		MATERIAL/EQUIP		LABOR		TOTAL COST	SOURCE	
	No.	Unit	$/Unit	Total	$/Unit	Total		Material	Labor
Fire tube boiler - 25,000mbh	2	Ea		0	32596	65,192	65,192		MMp 213
125 psig, gas & No.2 oil,									
Peripheral equip for boiler;	2	Ea	26993.5	53,987	8149	16,298	70,285	Use 25%	Use 25%
piping, pumps, deaerator,									
water treatment, etc.									
Economizer	2	Ea	18000	36,000	5000	10,000	46,000	Vendor	Vendor
Stack (50 ft each x 2)	100	L.F.		0	21.5	2,150	2,150		MMp 246
Building 36 x 40	1440	S.F.	33.6	48,384		0	48,384	MMp 360	
Subtotal Bare Costs				138,371		93,640	232,011		
Retrofit Cost Factors			0%	0	0%	0	0	MMp6	MMp6
Subtotal				138,371		93,640	232,011		
City Cost Index			0.952	(6,642)	0.632	(34,460)	(41,102)	MMp533	MMp533
Subtotal				131,729		59,180	190,909		
OH & Profit Markups			10%	13,173	53%	31,365	44,538	MMp7	MMp475
Subtotal				144,902		90,545	235,447		
State Sales Taxes			4.5%	6,521		N.A.	6,521	MMp476	
Subtotal				151,423		90,545	241,968		
Contingency			10%	15,142	10%	9,055	24,197	MEp6	MEp6
Total Construction Cost				166,565		99,600	$266,165		
Design Fee				N.A.	6.0%	15,970	15,970		
SIOH				N.A.	6.0%	15,970	15,970		
Total Project Cost				166,565		131,540	$298,105		

LEGEND:
- MEp### 1996 Means Electrical Cost Data, page ###.
- MMp### 1996 Means Mechanical Cost Data, page ###.
- Vendor Vendor estimate, see attached telephone call confirmation.

9/96

A.5. H2-11

Pine Bluff Arsenal

Energy Savings Calculations

ECO Number:	H2D	
		Notes
Building Number:	32-060	
Natural Gas consumption (MBtu/Yr):	107,613	(1)
Current Boiler Efficiency:	0.80	(2)
Boiler Efficiency w/ Economizer:	0.85	(3)

Notes:

(1) Assumes steam leaks are repaired, see attached calculation sheet.
(2) Efficiency of a new boiler with properly operating air-fuel controls.
(3) Efficiency with an economizer, (450°-250°)/40 = 5% improvement.

Energy Savings = (Improved efficiency - Current efficiency) x Natural gas consumption

= (0.85 - 0.80) x 107,613 MBtu/Yr

Energy Savings = 5,381 MBtu/Yr

CONSTRUCTION COST ESTIMATE

Project:	Modifications & Improvements to boilers in Bldg.32-060	RS&H No.:	694-1331-004
Location:	Pine Bluff Arsenal, AR	Date:	8/15/96
Basis:	Schematic Design	Estimator:	WTT
ECO Number:	H2-D: Retrofit economizers on surplus boilers.	Filename:	EST-H2D.XLS

ITEM DESCRIPTION	QUANTITY		MATERIAL/EQUIP		LABOR		TOTAL COST	SOURCE	
	No.	Unit	$/Unit	Total	$/Unit	Total		Material	Labor
Economizer for Y-S boiler	2	Ea	18000	36,000	5000	10,000	46,000	Vendor	Vendor
Peripheral equipment; piping, valves, controls, etc.	2	Ea	4500	9,000	1250	2,500	11,500	Use 25%	Use 25%
Remove stack (50 ft each)	100	L.F.		0	21.5	2,150	2,150		MMp 246
Re-install stack (50 ft each)	100	L.F.		0	21.5	2,150	2,150		MMp 246
Roof flashing, 28" dia.	2	Ea	259	518	63	126	644	MMp 244	MMp 244
Repair/replace roofing	50	SF	0.95	48	1.53	77	125	MRp 272	MRp 272
Hoist, truck mounted, 12 ton	1	Wk	2107	2,107	1070	1,070	3,177	MMp 15	MMp 475
Subtotal Bare Costs				47,673		18,073	65,746		
Retrofit Cost Factors			0%	0	0%	0	0	MMp6	MMp6
Subtotal				47,673		18,073	65,746		
City Cost Index			0.952	(2,288)	0.632	(6,651)	(8,939)	MMp533	MMp533
Subtotal				45,385		11,422	56,807		
OH & Profit Markups			10%	4,539	53%	6,054	10,593	MMp7	MMp475
Subtotal				49,924		17,476	67,400		
State Sales Taxes			4.5%	2,247		N.A.	2,247	MMp476	
Subtotal				52,171		17,476	69,647		
Contingency			10%	5,217	10%	1,748	6,965	MEp6	MEp6
Total Construction Cost				57,388		19,224	$76,612		
Design Fee				N.A.	6.0%	4,597	4,597		
SIOH				N.A.	6.0%	4,597	4,597		
Total Project Cost				57,388		28,418	$85,806		

LEGEND:

MEp###	1996 Means Electrical Cost Data, page ###.
MMp###	1996 Means Mechanical Cost Data, page ###.
MRp###	1991 Means Repair and Remodling Cost Data, page ###, exclated at 3%/yr.
Vendor	Vendor estimate, see attached telephone call confirmation.

A.5.H2-13

9/96

PINE BLUFF ARSENAL

Annual Energy Consumption in Production Area Boiler Buildings

1995 Energy Use Data (from boiler operating logs)

Area 32 Nat Gas Consumption (MBtu/yr) = 163,392

Area 33 Nat Gas Consumption (MBtu/yr) = 125,255

Area 34 Nat Gas Consumption (MBtu/yr) = 203,467

1995 Natural Gas Consumption in 32, 33 & 34 Boilers

Total Consumption (MBtu/yr) = Sum of Areas 32, 33 and 34

Total Consumption = 163,392 + 125,255 + 203,467

Total Consumption = 492,114 MBtu/yr

Percent Share of Total for Each Area

Area 32 = 163,392 / 492,114 = 33%

Area 33 = 125,255 / 492,114 = 25%

Area 34 = 203,467 / 492,114 = 41%

Energy Loss From Steam Leaks

Estimated energy loss due to steam leaks (1995) = 168,000 MBtu/yr

Estimated Energy Consumption w/o Steam Leaks

Forcast Consumption = Total Consumption for 1995 - Steam Leaks for 1995

= 492,114 − 168,000

= 324,114 MBtu/yr

Forcast Area Energy Consumption

Forcast area 32 = 324,114 × 33% =107,613 MBtu/yr

Forcast area 33 = 324,114 × 25% = 82,495 MBtu/yr

Forcast area 34 = 324,114 × 41%= 134,007 MBtu/yr

B#-CALC.XLS tab all
9/96

Determination of Average Annual boiler efficiency

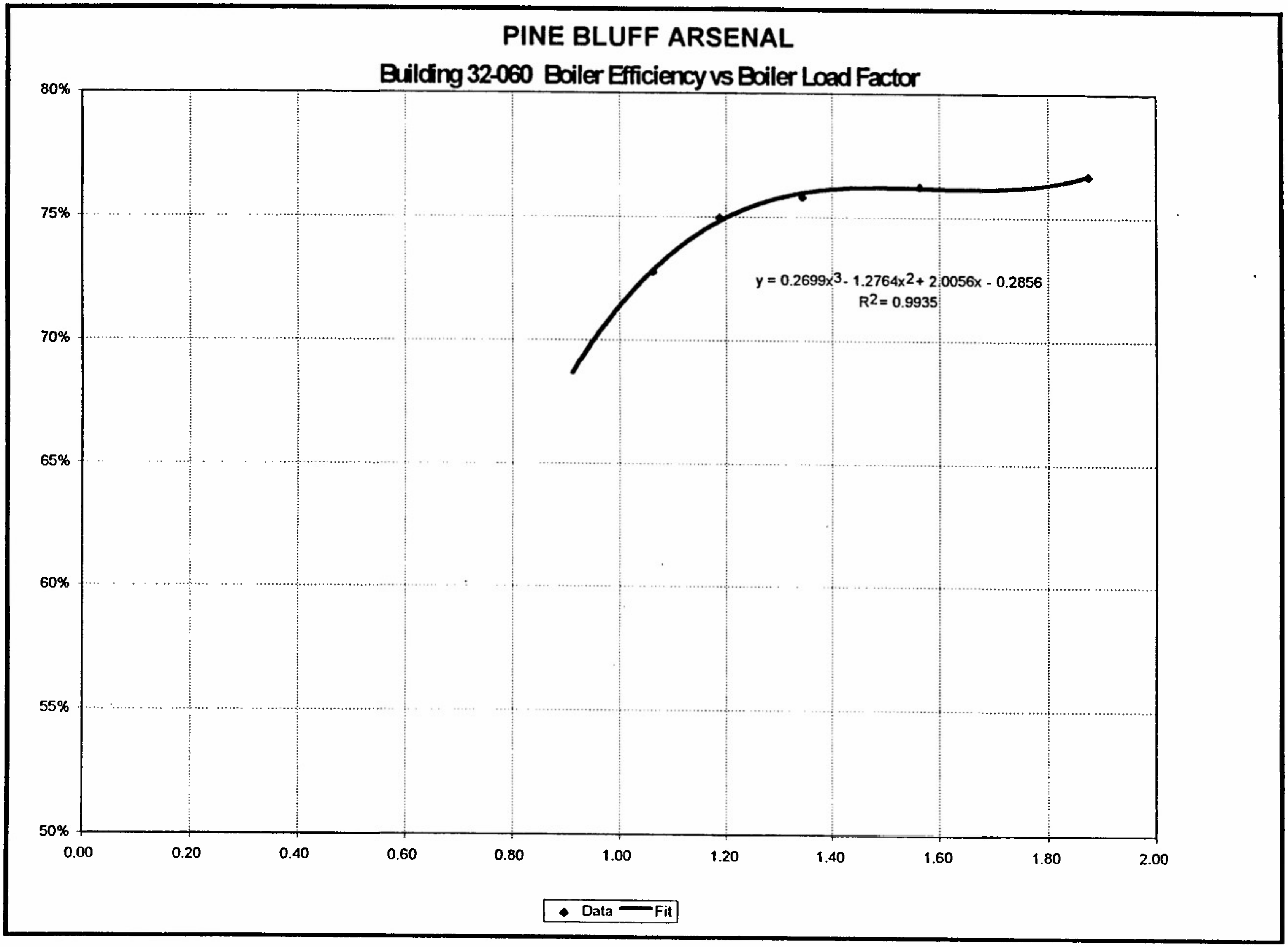
To determine the average annual boiler efficiency, stack gas analysis data was taken at five different boiler loads. The five load points ranged between the boiler's published 100% and 200% capacity because that is the range where the boiler typically operates . A curve was then drawn through the data points.

A monthly load factor was calculated from boiler operating logs. An annual average load factor was calculated from the monthly data and used to select an annual average boiler efficiency. The table below summarizes the results:

Building	Average Annual Load factor (1)	Average Annual Efficiency (2)
32-060	110%	74%
33-060	125%	75%
34-140	160%	72%

(1) Calculated from boiler operating logs. Boilers usually operate between 100% and 200% of published boiler capacity.

(2) Average annual efficiency of the boilers determined from attached graph at the average annual load factor.



PINE BLUFF ARSENAL
Building 32-060 Boiler Efficiency vs Boiler Load Factor
y = 0.2699x3 - 1.2764x2 + 2.0056x - 0.2856
R2 = 0.9935
80%
75%
70%
65%
60%
55%
50%
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
2.00
Data
Fit

RS&H

SUBJECT PBA ELEC & HTG STUDY
O & M SAVINGS
DESIGNER W. TODD
CHECKER

AEP NO 694-1331-004
SHEET ___ OF ___
DATE 6-25-96
DATE

Boiler & Compressor Maintenance Savings

The new boilers and compressors will have fully automatic control systems which will free up the operators to perform other tasks. Currently there are 3 operators during the day shift and one operator during the two night shifts. The operators must manually adjust the boilers and compressors to match the load.

With the new boilers and compressors, one day shift operator can be transfered to another position. Using a rate of $15 per hour the annual savings are:

Total Savings = $15/hr × 2080 hr/YR = $31,200/YR

Assuming the time the operator spent was distributed as follows: 80% Boilers, 20% Compressors.

Boiler Savings = $31200 × 0.8 = $24960/YR

Compressor Savings = $31200 × 0.2 = $6240/YR

Assuming the operators time is equally split among all boilers and compressors - the savings per boiler house is:

Boiler Savings = $24960/3 = $8,320/YR

Compressor Savings = $6240/3 = $2080/YR

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ILLINGWORTH
ENGINEERING
COMPANY
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DATE: 6/26/96

TO:

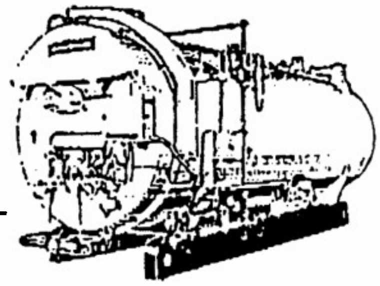
ATTN: [redacted]

FAX NO: 279-2489

FROM: CHUCK STRACENER

PAGES: 1 (Including Cover Sheet)

RE:



MESSAGE:

1EA 3/4 JACKSHAFT KIT P/N 880-339

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IF YOU DID NOT RECEIVE ALL THE PAGES, PLEASE CALL BACK AS SOON AS POSSIBLE.

A.5.H2-18 9/96

RS&H®

Telephone Call Confirmation

Project Number 694-1331-004

Local ______ L.D. X Placed X Rec'd ______ Date 6-4-96

Conversed with MARK CUTTER Of McCAIN ENGINEERING
PELHAM ALABAMA.

Regarding ECONOMIZER FOR YORK SHIPLEY BOILER

MAT'L COST ≈ $18,000 CIRCULAR ECONOMIZER

INSTALLATION ≈ $5000 BECAUSE NOT RETROFIT IF INSTALLED DURING CONSTRUCTION

George Fallon Jr.

Distribution:

A.5.H2-19

9/96

ECO-H3

Modifications and improvements to boilers in Building 33-060.

Option A - Install new boilers with turbulators, O_2 trim, economizers, etc.

Option B - Improve efficiency of existing boilers.

Option C - Install economizers on existing boilers.

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-H3
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: P B ARSENAL REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: ECO-3 BOILER MODIFICATIONS IN BUILDING 33-060
FISCAL YEAR 1997 DISCRETE PORTION NAME: OPTION A - NEW BOILERS
ANALYSIS DATE: 07-01-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

A. CONSTRUCTION COST	$ 581838.		
B. SIOH	$ 34911.		
C. DESIGN COST	$ 34911.		
D. TOTAL COST (1A+1B+1C)	$ 651660.		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F. PUBLIC UTILITY COMPANY REBATE		$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 651660.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 16.79	0.	$ 0.	15.08	$ 0.
B. DIST	$ .00	0.	$ 0.	18.57	$ 0.
C. RESID	$ .00	0.	$ 0.	21.02	$ 0.
D. NAT G	$ 2.81	9074.	$ 25498.	18.58	$ 473752.
E. COAL	$ .00	0.	$ 0.	16.83	$ 0.
F. PPG	$ .00	0.	$ 0.	17.38	$ 0.
M. DEMAND SAVINGS			$ 0.	14.88	$ 0.
N. TOTAL		9074.	$ 25498.		$ 473752.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 8320.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 123802.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 123802.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 33818.

5. SIMPLE PAYBACK PERIOD (1G/4) 19.27 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 597553.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= .92
(IF < 1 PROJECT DOES NOT QUALIFY)

9/96

LIFE CYCLE COST ANALYSIS SUMMARY   STUDY: ECO-H3
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)   LCCID FY95 (92)
INSTALLATION & LOCATION: P B ARSENAL   REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: ECO-3   BOILER MODIFICATIONS IN BUILDING 33-060
FISCAL YEAR 1997   DISCRETE PORTION NAME: OPTION B - FUEL/AIR CONTROLS
ANALYSIS DATE: 07-01-96   ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

A. CONSTRUCTION COST	$ 6378.		
B. SIOH	$ 383.		
C. DESIGN COST	$ 383.		
D. TOTAL COST (1A+1B+1C)	$ 7144.		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F. PUBLIC UTILITY COMPANY REBATE		$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 7144.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 16.79	0.	$ 0.	15.08	$ 0.
B. DIST	$ .00	0.	$ 0.	18.57	$ 0.
C. RESID	$ .00	0.	$ 0.	21.02	$ 0.
D. NAT G	$ 2.81	4125.	$ 11591.	18.58	$ 215365.
E. COAL	$ .00	0.	$ 0.	16.83	$ 0.
F. PPG	$ .00	0.	$ 0.	17.38	$ 0.
M. DEMAND SAVINGS			$ 0.	14.88	$ 0.
N. TOTAL		4125.	$ 11591.		$ 215365.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)		$ 0.
(1) DISCOUNT FACTOR (TABLE A)	14.88	
(2) DISCOUNTED SAVING/COST (3A X 3A1)		$ 0.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 0.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 11591.

5. SIMPLE PAYBACK PERIOD (1G/4) .62 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 215365.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 30.15
(IF < 1 PROJECT DOES NOT QUALIFY)

    9/96

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-H3
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: P B ARSENAL REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: ECO-3 BOILER MODIFICATIONS IN BUILDING 33-060
FISCAL YEAR 1997 DISCRETE PORTION NAME: OPTION C - INSTALL ECONOMIZERS
ANALYSIS DATE: 08-26-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

A. CONSTRUCTION COST	$ 117919.		
B. SIOH	$ 7076.		
C. DESIGN COST	$ 7076.		
D. TOTAL COST (1A+1B+1C)	$ 132071.		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F. PUBLIC UTILITY COMPANY REBATE		$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 132071.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 16.79	0.	$ 0.	15.08	$ 0.
B. DIST	$ .00	0.	$ 0.	18.57	$ 0.
C. RESID	$ .00	0.	$ 0.	21.02	$ 0.
D. NAT G	$ 2.81	3919.	$ 11012.	18.58	$ 204610.
E. COAL	$ .00	0.	$ 0.	16.83	$ 0.
F. PPG	$ .00	0.	$ 0.	17.38	$ 0.
M. DEMAND SAVINGS			$ 0.	14.88	$ 0.
N. TOTAL		3919.	$ 11012.		$ 204610.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 0.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 11012.

5. SIMPLE PAYBACK PERIOD (1G/4) 11.99 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 204610.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 1.55
(IF < 1 PROJECT DOES NOT QUALIFY)

Pine Bluff Arsenal

Energy Savings Calculations

ECO Number:	H3A	
		Notes
Building Number:	33-060	
Natural Gas consumption (MBtu/Yr):	82,495	(1)
Current Boiler Efficiency:	0.75	(2)
New/Improved Boiler Efficiency:	0.86	(3)

Notes:

(1) Assumes steam leaks are repaired, see attached calculation sheet.
(2) Actual efficiency calculated from field measurements.
(3) Efficiency of a new or properly operating boiler with an economizer.

Energy Savings = (Improved efficiency - Current efficiency) x Natural gas consumption

= (0.86 - 0.75) x 82,495 MBtu/yr

Energy Savings = 9,074 MBtu/yr

CONSTRUCTION COST ESTIMATE

Project:	Modifications & Improvements to boilers in Bldg.33-060	RS&H No.:	694-1331-004
Location:	Pine Bluff Arsenal, AR	Date:	6/27/96
Basis:	Schematic Design	Estimator:	GWF
ECO Number:	H3-A: Install new boilers w/ turbulators, O_2 Trim, economizers, etc.	Filename:	EST-H3A.XLS

ITEM DESCRIPTION	QUANTITY		MATERIAL/EQUIP		LABOR		TOTAL COST	SOURCE	
	No.	Unit	$/Unit	Total	$/Unit	Total		Material	Labor
Fire tube boiler - 25,000mbh	2	ea	107974	215,949	32596.1	65,192	$ 281,141	MMp 213	MMp 213
125 psig, gas & No.2 oil,									
Peripheral equip. for boiler;	2	ea	26993.6	53,987	8149.01	16,298	$ 70,285	Use 25%	Use 25%
piping, pumps, deaerator,									
water treatment, etc.									
Economizer	2	ea	18000	36,000	5000	10,000	$ 46,000	Vendor	Vendor
Stack (50 ft each x 2)	100	L.F.	139	13,900	21.5	2,150	$ 16,050	MMp 246	MMp 246
O_2 Trim controls	2	ea	2555	5,110		0	$ 5,110	MMp 318	
Demolition ductwork	40	L.F.		0	2.99	120	$ 120		MMp 20
Demolition boilers (2)	88	ton		0	395	34,614	$ 34,614		MMp 20
Bulk Asbestos Removal	2000	SF	0.69	1,380	5.72	11,430	$ 12,810	MMp 23	MMp 23
Collect and bag asbes.	220	Bag	1.2	264	4.58	1,008	$ 1,272	MMp 24	MMp 24
Containerize full bags	220	Ea	2.42	532	2.29	504	$ 1,036	MMp 24	MMp 24
Asbes. disposal charges	24	CY		0	160	3,911	$ 3,911		MMp 24
Subtotal Bare Costs				327,122		145,227	472,349		
Retrofit Cost Factors			5%	16,356	9%	13,070	29,426	MMp6	MMp6
Subtotal				343,478		158,297	501,775		
City Cost Index			0.952	(16,487)	0.632	(58,253)	(74,740)	MMp533	MMp533
Subtotal				326,991		100,044	427,035		
OH & Profit Markups			10%	32,699	53%	53,023	85,722	MMp7	MMp475
Subtotal				359,690		153,067	512,757		
State Sales Taxes			4.5%	16,186		N.A.	16,186	MMp476	
Subtotal				375,876		153,067	528,943		
Contingency			10%	37,588	10%	15,307	52,895	MEp6	MEp6
Total Construction Cost				**413,464**		**168,374**	**$581,838**		
Design Fee				N.A.	6.0%	34,910	34,910		
SIOH				N.A.	6.0%	34,910	34,910		
Total Project Cost				**413,464**		**238,194**	**$651,658**		

LEGEND:

- MEp### 1996 Means Electrical Cost Data, page ###.
- MMp### 1996 Means Mechanical Cost Data, page ###.
- Vendor Vendor estimate, see attached telephone call confirmation.

A.5.H3-6

9/96

Pine Bluff Arsenal

Energy Savings Calculations

ECO Number:	H3B	
		Notes
Building Number:	33-060	
Natural Gas consumption (MBtu/Yr):	82,495	(1)
Current Boiler Efficiency:	0.75	(2)
New/Improved Boiler Efficiency:	0.80	(3)

Notes:

(1) Assumes steam leaks are repaired, see attached calculation sheet.
(2) Actual efficiency calculated from field measurements.
(3) Efficiency of a new or properly operating boiler.

Energy Savings = (Improved efficiency - Current efficiency) x Natural gas consumption

= (0.80 - 0.75) x 82,495 MBtu/yr

Energy Savings = 4,125 MBtu/yr

CONSTRUCTION COST ESTIMATE

Project:	Modifications & Improvements to boilers in Bldg.33-060	RS&H No.:	694-1331-004
Location:	Pine Bluff Arsenal, AR	Date:	6/26/96
Basis:	Schematic Design	Estimator:	GWF
ECO Number:	H3-B: Improve efficiency of existing boilers	Filename:	EST-H3B.XLS

ITEM DESCRIPTION	QUANTITY No.	QUANTITY Unit	MATERIAL/EQUIP $/Unit	MATERIAL/EQUIP Total	LABOR $/Unit	LABOR Total	TOTAL COST	SOURCE Material	SOURCE Labor
Jackshaft cam kit for boiler	2	Ea	527.82	1,056	2400	4,800	5,856	Vendor	Est. (1)
Subtotal Bare Costs				1,056		4,800	5,856		
Retrofit Cost Factors			0%	0	0%	0	0	MMp6	MMp6
Subtotal				1,056		4,800	5,856		
City Cost Index			0.952	(51)	0.632	(1,766)	(1,817)	MMp533	MMp533
Subtotal				1,005		3,034	4,039		
OH & Profit Markups			10%	101	53%	1,608	1,709	MMp7	MMp475
Subtotal				1,106		4,642	5,748		
State Sales Taxes			4.5%	50		N.A.	50	MMp476	
Subtotal				1,156		4,642	5,798		
Contingency			10%	116	10%	464	580	MEp6	MEp6
Total Construction Cost				**1,272**		**5,106**	**$6,378**		
Design Fee				N.A.	6.0%	383	383		
SIOH				N.A.	6.0%	383	383		
Total Project Cost				**1,272**		**5,872**	**$7,144**		

LEGEND:

Note (1)	Assumes 3 days to install, $800 per day for labor and expenses.
MEp###	1996 Means Electrical Cost Data, page ###.
MMp###	1996 Means Mechanical Cost Data, page ###.
Vendor	Vendor quote, see attached fax.

A.5.H3-8

9/96

Pine Bluff Arsenal

Energy Savings Calculations

ECO Number:	H3C	
		Notes
Building Number:	33-060	
Natural Gas consumption (MBtu/Yr):	78,370	(1)
Boiler Efficiency w/Air-Fuel Controls:	0.80	(2)
Improved Boiler Efficiency w/ Economizer:	0.85	(3)

Notes:

(1) Assumes steam leaks are repaired and air-fuel controls installed.
(2) Efficiency of a boiler with properly operating air-fuel controls.
(3) Efficiency with an economizer, (450°-250°)/40 = 5% improvement.

Energy Savings = (Improved efficiency - Current efficiency) x Natural gas consumption

= (0.85 - 0.80) x 78,370 MBtu/Yr

Energy Savings = 3,919 MBtu/Yr

ECO-H3C

Buildings 33-060 Economizers

Installing economizers on old boilers requires a careful analysis of both the gas side and the feedwater side of the process. With the economizer in place the gas side pressure drop will increase and the stack draft will decrease due to the lower stack temperature. Both these effects combine to increase the furnace pressure. If the furnace is designed for negative pressure, care must be taken to design the economizer and ductwork to maintain the furnace pressure below atmospheric pressure at high loads. On the water side, care must be taken to assure that steaming in the economizer can never occur at any load; and, that the stack will not be damaged by internal condensation by operating at too low a temperature in cold weather. An economizer can be designed to successfully operate within these constraints, but the ductwork downstream of the boilers may have to be replaced to provide the proper economizer performance.

Two practical configurations are possible. First, the existing configuration with a common plenum and single stack can be maintained, but the exhaust plenum will probably have to be replaced. The new plenum will likely have to be larger than the existing plenum to reduce pressure drop. The larger plenum will be heavier, perhaps requiring local roof reinforcement. Furthermore, "man-safe" dampers must be placed at the plenum penetration point from each boiler so each boiler may be isolated for gas side maintenance including the economizer. If the "man-safe" dampers are not installed then all of the boilers in that building will have to be shutdown to do gas side maintenance on any one of the boilers. Shutting down either building during the winter will be possible if the leaks in the steam system are fixed.

The second possible configuration is to keep the gas streams from each boiler separate from each other. In this case no dampers will be required, but each boiler will require its own 45 to 50 foot tall, roof mounted stack. The stack will require local roof reinforcement on each building. Alternatively, the stack can be ground supported if the roof modifications are too expensive. From an operating and maintenance view this is the more desirable configuration since the operation of one boiler does not impact the other.

CONSTRUCTION COST ESTIMATE

Project:	Install economizers on boilers in Bldg.33-060	RS&H No.:	694-1331-004
Location:	Pine Bluff Arsenal, AR	Date:	8/15/96
Basis:	Schematic Design	Estimator:	GWF
ECO Number:	H3-C	Filename:	EST-H3CF.XLS

ITEM DESCRIPTION	QUANTITY No.	QUANTITY Unit	MATERIAL/EQUIP $/Unit	MATERIAL/EQUIP Total	LABOR $/Unit	LABOR Total	TOTAL COST	SOURCE Material	SOURCE Labor
Bulk Asbestos Removal	640	SF	0.69	442	5.72	3,658	4,100	MMp 23	MMp 23
Decontam. chamber	100	SF	2.12	212	1.44	144	356	MMp 23	MMp 23
Collect and bag asbestos	70	Bag	1.2	84	4.58	322	406	MMp 24	MMp 24
Containerize full bags	70	Ea	2.42	170	2.29	161	331	MMp 24	MMp 24
Asbestos disposal	8	CY		0	160	1,252	1,252		MMp 24
Demolition duct & plenum	1.51	Ton		0	485	733	733		MMp 21
Boiler Economizer	2	ea	18000	36,000	5000	10,000	46,000	Vendor	Vendor
Peripheral equipment; pipe, valves, controls, etc.	2	ea	4500	9,000	1250	2,500	11,500	Use 25%	Use 25%
Stack, 28" dia. (50 ft each)	100	L.F.	139	13,900	21.5	2,150	16,050	MMp 246	MMp 246
Elbow, 28" dia., 90°, fixed	2	Ea	825	1,650	43	86	1,736	MMp 246	MMp 246
Structural support	3000	lb	0.95	2,850	0.36	1,080	3,930	MMp 54	MMp 54
Roof flashing, 28" dia.	2	Ea	259	518	63	126	644	MMp 244	MMp 244
Repair/replace roofing	180	SF	0.95	171	1.53	275	446	MRp 272	MRp 272
Hoist, truck mounted, 12 ton	1	Wk	2107	2,107	1070	1,070	3,177	MMp 15	MMp 475
Subtotal Bare Costs				67,104		23,557	90,661		
Retrofit Cost Factors			10%	6,710	16%	3,769	10,479	MMp6	MMp6
Subtotal				73,814		27,326	101,140		
City Cost Index			0.952	(3,543)	0.632	(10,056)	(13,599)	MMp533	MMp533
Subtotal				70,271		17,270	87,541		
OH & Profit Markups			10%	7,027	53%	9,153	16,180	MMp7	MMp475
Subtotal				77,298		26,423	103,721		
State Sales Taxes			4.5%	3,478		N.A.	3,478	MMp476	
Subtotal				80,776		26,423	107,199		
Contingency			10%	8,078	10%	2,642	10,720	MEp6	MEp6
Total Construction Cost				**88,854**		**29,065**	**$117,919**		
Design Fee				N.A.	6.0%	7,075	7,075		
SIOH				N.A.	6.0%	7,075	7,075		
Total Project Cost				**88,854**		**43,215**	**$132,069**		

LEGEND:

MEp###	1996 Means Electrical Cost Data, page ###.
MMp###	1996 Means Mechanical Cost Data, page ###.
MRp###	1991 Means Repair and Remodling Cost Data, page ###, exclated at 3%/yr.
Vendor	Vendor estimate, see attached telephone call confirmation.

A.5.H3-11

9/96

PINE BLUFF ARSENAL

Annual Energy Consumption in Production Area Boiler Buildings

1995 Energy Use Data (from boiler operating logs)

Area 32 Nat Gas Consumption (MBtu/yr) = 163,392

Area 33 Nat Gas Consumption (MBtu/yr) = 125,255

Area 34 Nat Gas Consumption (MBtu/yr) = 203,467

1995 Natural Gas Consumption in 32, 33 & 34 Boilers

Total Consumption (MBtu/yr) = Sum of Areas 32, 33 and 34

Total Consumption = 163,392 + 125,255 + 203,467

Total Consumption = 492,114 MBtu/yr

Percent Share of Total for Each Area

Area 32 = 163,392 / 492,114 = 33%

Area 33 = 125,255 / 492,114 = 25%

Area 34 = 203,467 / 492,114 = 41%

Energy Loss From Steam Leaks

Estimated energy loss due to steam leaks (1995) = 168,000 MBtu/yr

Estimated Energy Consumption w/o Steam Leaks

Forcast Consumption = Total Consumption for 1995 - Steam Leaks for 1995

= 492,114 - 168,000

= 324,114 MBtu/yr

Forcast Area Energy Consumption

Forcast area 32 = 324,114 × 33% =107,613 MBtu/yr

Forcast area 33 = 324,114 × 25% = 82,495 MBtu/yr

Forcast area 34 = 324,114 x 41%= 134,007 MBtu/yr

Determination of Average Annual boiler efficiency

To determine the average annual boiler efficiency, stack gas analysis data was taken at five different boiler loads. The five load points ranged between the boiler's published 100% and 200% capacity because that is the range where the boiler typically operates . A curve was then drawn through the data points.

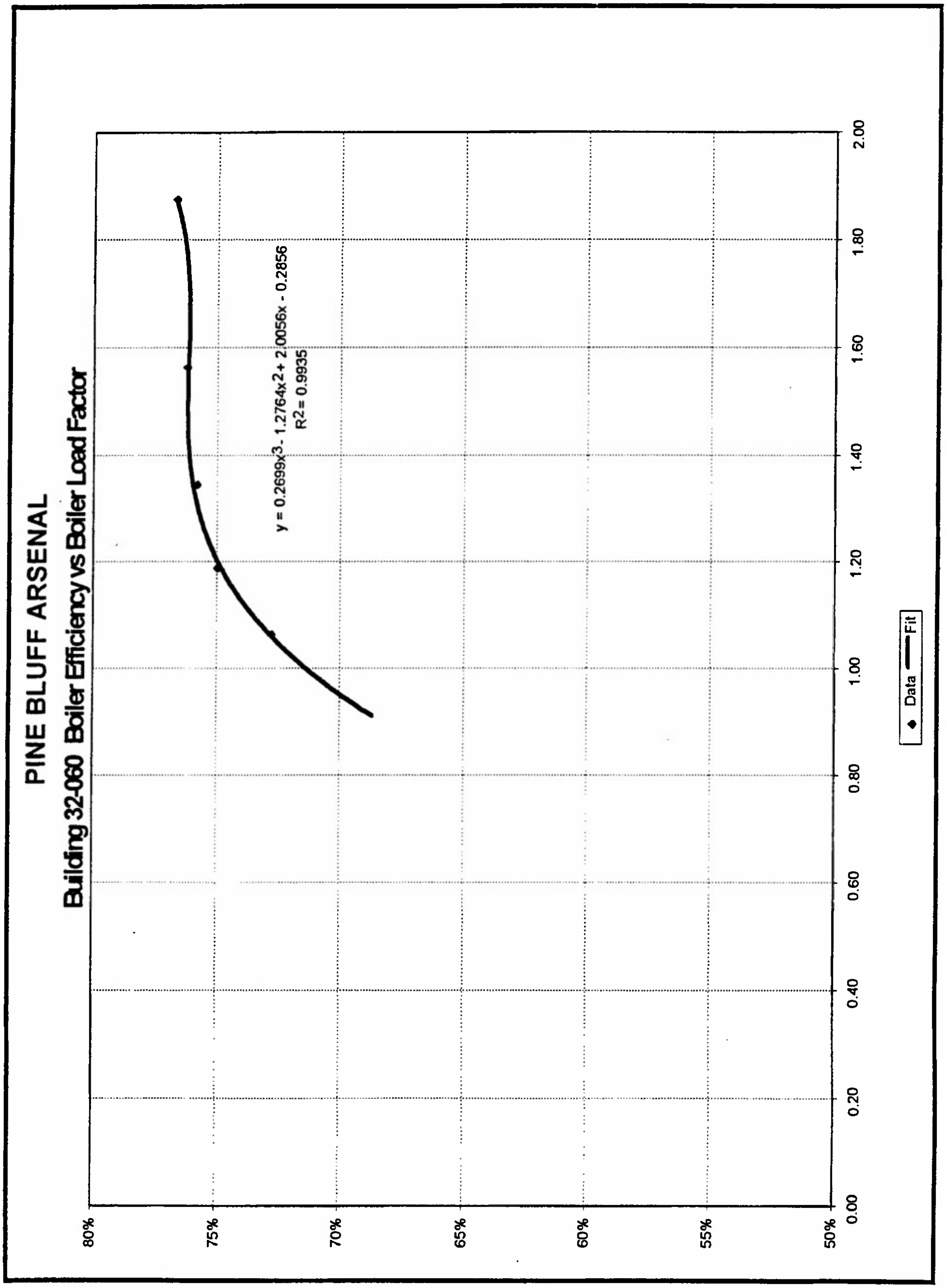
A monthly load factor was calculated from boiler operating logs. An annual average load factor was calculated from the monthly data and used to select an annual average boiler efficiency. The table below summarizes the results:

Building	Average Annual Load factor (1)	Average Annual Efficiency (2)
32-060	110%	74%
33-060	125%	75%
34-140	160%	72%

(1) Calculated from boiler operating logs. Boilers usually operate between 100% and 200% of published boiler capacity.

(2) Average annual efficiency of the boilers determined from attached graph at the average annual load factor.

9/96


PINE BLUFF ARSENAL
Building 32-060 Boiler Efficiency vs Boiler Load Factor
y = 0.2699x3 - 1.2764x2 + 2.0056x - 0.2856
R2 = 0.9935
80%
75%
70%
65%
60%
55%
50%
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
2.00
Data
Fit

A.5.H3-14

9/96

Boiler & Compressor Maintenance Savings

The new boilers and compressors will have fully automatic control systems which will free up the operators to perform other tasks. Currently there are 3 operators during the day shift and one operator during the two night shifts. The operators must manually adjust the boilers and compressors to match the load.

With the new boilers and compressors, one day shift operator can be transfered to another position. Using a rate of \$15 per hour the annual savings are:

Total Savings = \$15 /hr x 2080 hr/YR = \$31,200 /YR

Assuming the time the operator spent was distributed as follows: 80% Boilers, 20% Compressors.

Boiler Savings = \$31200 x 0.8 = \$24960 /YR

Compressor Savings = \$31200 x 0.2 = \$6240/YR

Assuming the operators time is equally split among all boilers and compressors - the savings per boiler house is:

Boiler Savings = \$24960 /3 = \$8,320 /YR

Compressor Savings = \$6240 /3 = \$2080 /YR

RS&H®

Telephone Call Confirmation

Project Number 694-1331-004

Local ______ L.D. X Placed X Rec'd ______ Date 6-4-96

Conversed with MARK CUTTER Of McCAIN ENGINEERING
PELHAM ALABAMA.

Regarding ECONOMIZER FOR YORK SHIPLEY BOILER

MAT'L COST ≈ $18,000 CIRCULAR ECONOMIZER

INSTALLATION ≈ $5000 BECAUSE NOT RETROFIT IF
INSTALLED DURING CONSTRUCTION

George Fallon III

Distribution:

A.5.H3-16

9/96

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ATTN: [redacted]

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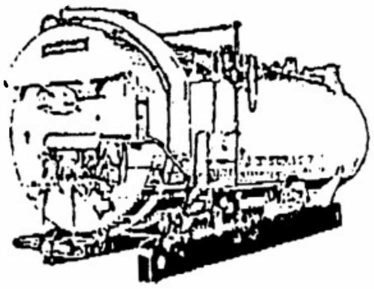
FROM: CHUCK STRACENER



PAGES: 1 (Including Cover Sheet)

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$ 529.82

IF YOU DID NOT RECEIVE ALL THE PAGES, PLEASE CALL BACK AS SOON AS POSSIBLE.

9/96

A.5.H3-17

ECO-H4

Modifications and improvements to boilers in Building 34-140.

Option A - Install new boilers with turbulators, O_2 trim, economizers, etc.

Option B - Improve efficiency of existing boilers.

Option C - Install economizers on existing boilers.

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-H4
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: P B ARSENAL REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: ECO-H4 BOILER MODIFICATIONS IN BUILDING 34-140
FISCAL YEAR 1997 DISCRETE PORTION NAME: OPTION A - NEW BOILERS
ANALYSIS DATE: 07-01-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

A. CONSTRUCTION COST	$ 756116.		
B. SIOH	$ 45367.		
C. DESIGN COST	$ 45367.		
D. TOTAL COST (1A+1B+1C)	$ 846850.		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F. PUBLIC UTILITY COMPANY REBATE		$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 846850.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 16.79	0.	$ 0.	15.08	$ 0.
B. DIST	$ .00	0.	$ 0.	18.57	$ 0.
C. RESID	$ .00	0.	$ 0.	21.02	$ 0.
D. NAT G	$ 2.81	18761.	$ 52718.	18.58	$ 979508.
E. COAL	$ .00	0.	$ 0.	16.83	$ 0.
F. PPG	$ .00	0.	$ 0.	17.38	$ 0.
M. DEMAND SAVINGS			$ 0.	14.88	$ 0.
N. TOTAL		18761.	$ 52718.		$ 979508.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 8320.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 123802.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 123802.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 61038.

5. SIMPLE PAYBACK PERIOD (1G/4) 13.87 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 1103310.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 1.30
(IF < 1 PROJECT DOES NOT QUALIFY)

 9/96

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-H4
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: P B ARSENAL REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: ECO-H4 BOILER MODIFICATIONS IN BUILDING 34-140
FISCAL YEAR 1997 DISCRETE PORTION NAME: OPTION B - BOILER MODIFICATIONS
ANALYSIS DATE: 08-26-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

A. CONSTRUCTION COST	$ 64702.		
B. SIOH	$ 3883.		
C. DESIGN COST	$ 3883.		
D. TOTAL COST (1A+1B+1C)	$ 72468.		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F. PUBLIC UTILITY COMPANY REBATE		$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 72468.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 16.79	0.	$ 0.	15.08	$ 0.
B. DIST	$ .00	0.	$ 0.	18.57	$ 0.
C. RESID	$ .00	0.	$ 0.	21.02	$ 0.
D. NAT G	$ 2.81	12657.	$ 35566.	18.58	$ 660819.
E. COAL	$ .00	0.	$ 0.	16.83	$ 0.
F. PPG	$ .00	0.	$ 0.	17.38	$ 0.
M. DEMAND SAVINGS			$ 0.	14.88	$ 0.
N. TOTAL		12657.	$ 35566.		$ 660819.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 0.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 35566.

5. SIMPLE PAYBACK PERIOD (1G/4) 2.04 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 660819.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 9.12
(IF < 1 PROJECT DOES NOT QUALIFY)

 9/96

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-H4
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: P B ARSENAL REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: ECO-H4 BOILER MODIFICATIONS IN BUILDING 34-140
FISCAL YEAR 1997 DISCRETE PORTION NAME: OPTION C - INSTALL ECONOMIZERS
ANALYSIS DATE: 08-26-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

A. CONSTRUCTION COST	$ 174599.		
B. SIOH	$ 10476.		
C. DESIGN COST	$ 10476.		
D. TOTAL COST (1A+1B+1C)	$ 195551.		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F. PUBLIC UTILITY COMPANY REBATE		$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 195551.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 16.79	0.	$ 0.	15.08	$ 0.
B. DIST	$ .00	0.	$ 0.	18.57	$ 0.
C. RESID	$ .00	0.	$ 0.	21.02	$ 0.
D. NAT G	$ 2.81	6164.	$ 17321.	18.58	$ 321821.
E. COAL	$ .00	0.	$ 0.	16.83	$ 0.
F. PPG	$ .00	0.	$ 0.	17.38	$ 0.
M. DEMAND SAVINGS			$ 0.	14.88	$ 0.
N. TOTAL		6164.	$ 17321.		$ 321821.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 0.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 17321.

5. SIMPLE PAYBACK PERIOD (1G/4) 11.29 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 321821.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 1.65
(IF < 1 PROJECT DOES NOT QUALIFY)

9/96

Pine Bluff Arsenal
Energy Savings Calculations

ECO Number:	H4A	
		Notes
Building Number:	34-140	
Natural Gas consumption (MBtu/Yr):	134,007	(1)
Current Boiler Efficiency:	0.72	(2)
New/Improved Boiler Efficiency:	0.86	(3)

Notes:
(1) Assumes steam leaks are repaired, see attached calculation sheet.
(2) Actual efficiency calculated from field measurements.
(3) Efficiency of a new or properly operating boiler with an economizer.

Energy Savings = (Improved efficiency - Current efficiency) x Natural gas consumption

= (0.86 - 0.72) x 134,007 MBtu/yr

Energy Savings = 18,761 MBtu/yr

CONSTRUCTION COST ESTIMATE

Project:	Modifications & Improvements to boilers in Bldg.34-140	RS&H No.:	694-1331-004
Location:	Pine Bluff Arsenal, AR	Date:	6/27/96
Basis:	Schematic Design	Estimator:	GWF
ECO Number:	H4-A: Install new boilers w/ turbulators, O_2 Trim, economizers, etc.	Filename:	EST-H4A.XLS

ITEM DESCRIPTION	QUANTITY No.	QUANTITY Unit	MATERIAL/EQUIP $/Unit	MATERIAL/EQUIP Total	LABOR $/Unit	LABOR Total	TOTAL COST	SOURCE Material	SOURCE Labor
Fire tube boiler - 20,000mbh	3	ea	91881	275,642	26851	80,554	$ 356,196	MMp 213	MMp 213
125 psig, gas & No.2 oil,									
Peripheral equip. for boiler;	3	ea	22970	68,910	6712.8	20,138	$ 89,048	Use 25%	Use 25%
piping, pumps, deaerator,									
water treatment, etc.									
Economizer	3	ea	18000	54,000	5000	15,000	$ 69,000	Vendor	Vendor
Stack (50 ft each x 3)	150	L.F.	139	20,850	21.5	3,225	$ 24,075	MMp 246	MMp 246
O_2 Trim Controls	3	ea	2555	7,665		0	$ 7,665	MMp 318	
Demolition ductwork	60	L.F.		0	2.99	179	$ 179		MMp 20
Demolition boilers (3 each)	105	ton		0	395	41,537	$ 41,537		MMp 20
Bulk Asbestos Removal	2700	SF	0.69	1,863	5.715	15,431	$ 17,294	MMp 23	MMp 23
Collect and bag asbest.	297	Bag	1.2	356	4.58	1,360	$ 1,716	MMp 24	MMp 24
Containerize full bags	297	Ea	2.42	719	2.29	680	$ 1,399	MMp 24	MMp 24
Asbestos disposal	33	CY		0	160	5,280	$ 5,280		MMp 24
Subtotal Bare Costs				430,005		183,384	613,389		
Retrofit Cost Factors			5%	21,500	9%	16,505	38,005	MMp6	MMp6
Subtotal				451,505		199,889	651,394		
City Cost Index			0.952	(21,672)	0.632	(73,559)	(95,231)	MMp533	MMp533
Subtotal				429,833		126,330	556,163		
OH & Profit Markups			10%	42,983	53%	66,955	109,938	MMp7	MMp475
Subtotal				472,816		193,285	666,101		
State Sales Taxes			4.5%	21,277		N.A.	21,277	MMp476	
Subtotal				494,093		193,285	687,378		
Contingency			10%	49,409	10%	19,329	68,738	MEp6	MEp6
Total Construction Cost				543,502		212,614	$756,116		
Design Fee				N.A.	6.0%	45,367	45,367		
SIOH				N.A.	6.0%	45,367	45,367		
Total Project Cost				543,502		303,348	$846,850		

LEGEND:

MEp###	1996 Means Electrical Cost Data, page ###.
MMp###	1996 Means Mechanical Cost Data, page ###.
Vendor	Vendor estimate, see attached telephone call confirmation.

A.5.H4-6

9/96

Pine Bluff Arsenal

Energy Savings Calculations

ECO Number:	H4B	
		Notes
Building Number:	34-140	
Natural Gas consumption (MBtu/Yr):	134,007	(1)
Current Boiler Efficiency:	0.72	(2)
New/Improved Boiler Efficiency:	0.80	(3)

Notes:

(1) Assumes steam leaks are repaired, see attached calculation sheet.
(2) Actual efficiency calculated from field measurements.
(3) Efficiency of a new or properly operating boiler.

Energy Savings = (Improved efficiency - Current efficiency) x Natural gas consumption

= (0.80 − 0.72) x 134,007 MBtu/yr

Energy Savings = 10,721 MBtu/yr

RS&H

SUBJECT Pine Bluff Arsenal
ECO - H4B
DESIGNER GWF
CHECKER

AEP NO
SHEET 1 OF 1
DATE 6-28-96
DATE

ECO - H4B

CALCULATE ANNUAL HEAT LOSS FROM HEATER VENT

ASSUME 5 ft/sec EXIT VELOCITY (BASED ON VISUAL OBSERVATION)

VENT DIA (IN) = 6
VENT PRES. (PSIG) = 1 => 26.3 CF/# ; 1151 BTU/# STEAM
BOILER EFF (%) = 70
NAT. GAS COST ($) = 2.81

AREA OF VENT

$$A = \frac{\pi}{4} D^2 = 0.785 \times \left(\frac{6}{12}\right)^2 = 0.196\ ft^2$$

VENT FLOW

FLOW = AREA x VELOCITY
= 0.196 ft² x 5 ft/sec x 3600 SEC/HR x 1 LB/26.3 CF
= 134 LBS STEAM/HR

134 LBS/HR x 8760 Hr/yr = 1.177 million LBS/yr.

ENERGY LOST

1.177×10^6 LBS/yr x 1151 B/LB / 0.7 = 1936 mB/yr

ANNUAL COST

1936 MB/yr x \$2.81/MB = \$5439/YR

CONSTRUCTION COST ESTIMATE

Project:	Modifications & Improvements to boilers in Bldg.34-140	RS&H No.:	694-1331-004
Location:	Pine Bluff Arsenal, AR	Date:	8/12/96
Basis:	Schematic Design	Estimator:	GWF
ECO Number:	H4-B: Improve efficiency of existing bollers.	Filename:	EST-H4B.XLS

ITEM DESCRIPTION	QUANTITY		MATERIAL/EQUIP		LABOR		TOTAL COST	SOURCE	
	No.	Unit	$/Unit	Total	$/Unit	Total		Material	Labor
Jackshaft cam kit for boiler	3	Ea	527.82	1,583	2400	7,200	8,783	Vendor (1)	Est. (1)
Deaerator 900 gal	1	ea	19600	19,600	19000	19,000	38,600	Vendor (2)	Est. (2)
Deaerator Stand	1	ea	5000	5,000	2000	2,000	7,000	Vendor (2)	Est. (2)
Demolish existing heater	3	Tons	0	0	485	1,455	1,455	MMp 21	MMp 21
Asbestos Abatement	100	SF	1.25	125	10.40	1,040	1,165	MMp 24	MMp 24
Asbestos Disposal	2	CY	160	320		0	320	MMp 24	MMp 24
Subtotal Bare Costs				26,628		30,695	57,323		
Retrofit Cost Factors			0%	0	0%	0	0	MMp6	MMp6
Subtotal				26,628		30,695	57,323		
City Cost Index			0.952	(1,278)	0.632	(11,296)	(12,574)	MMp533	MMp533
Subtotal				25,350		19,399	44,749		
OH & Profit Markups			10%	2,535	53%	10,281	12,816	MMp7	MMp475
Subtotal				27,885		29,680	57,565		
State Sales Taxes			4.5%	1,255		N.A.	1,255	MMp476	
Subtotal				29,140		29,680	58,820		
Contingency			10%	2,914	10%	2,968	5,882	MEp6	MEp6
Total Construction Cost				**32,054**		**32,648**	**$64,702**		
Design Fee				N.A.	6.0%	3,882	3,882		
SIOH				N.A.	6.0%	3,882	3,882		
Total Project Cost				**32,054**		**40,412**	**$72,466**		

LEGEND:

Est. (1)	Assumes 3 days to install, $800 per day for labor and expenses.
Est. (2)	Rule of thumb: Installed cost is double material costs
MEp###	1996 Means Electrical Cost Data, page ###.
MMp###	1996 Means Mechanical Cost Data, page ###.
Vendor (1)	Vendor quote, see attached fax from Illingworth Engineering.
Vendor (2)	Vendor quote, see attached phone quote from Illingworth Engineering.

A.5.H4-9

9/96

Pine Bluff Arsenal

Energy Savings Calculations

ECO Number:	H4C	
		Notes
Building Number:	34-140	
Natural Gas consumption (MBtu/Yr):	123,286	(1)
Boiler Efficiency w/Air-Fuel Controls:	0.80	(2)
Improved Boiler Efficiency w/ Economizer:	0.85	(3)

Notes:

(1) Assumes steam leaks are repaired and air-fuel controls installed.
(2) Efficiency of a boiler with properly operating air-fuel controls.
(3) Efficiency with an economizer, (450°-250°)/40 = 5% improvement.

Energy Savings = (Improved efficiency - Current efficiency) x Natural gas consumption

= (0.85 - 0.80) x 123,286 MBtu/Yr

Energy Savings = 6,164 MBtu/Yr

Buildings 34-140 Economizers

Installing economizers on old boilers requires a careful analysis of both the gas side and the feedwater side of the process. With the economizer in place the gas side pressure drop will increase and the stack draft will decrease due to the lower stack temperature. Both these effects combine to increase the furnace pressure. If the furnace is designed for negative pressure, care must be taken to design the economizer and ductwork to maintain the furnace pressure below atmospheric pressure at high loads. On the water side, care must be taken to assure that steaming in the economizer can never occur at any load; and, that the stack will not be damaged by internal condensation by operating at too low a temperature in cold weather. An economizer can be designed to successfully operate within these constraints, but the ductwork downstream of the boilers may have to be replaced to provide the proper economizer performance.

Two practical configurations are possible. First, the existing configuration with a common plenum and single stack can be maintained, but the exhaust plenum will probably have to be replaced. The new plenum will likely have to be larger than the existing plenum to reduce pressure drop. The larger plenum will be heavier, perhaps requiring local roof reinforcement. Furthermore, "man-safe" dampers must be placed at the plenum penetration point from each boiler so each boiler may be isolated for gas side maintenance including the economizer. If the "man-safe" dampers are not installed then all of the boilers in that building will have to be shutdown to do gas side maintenance on any one of the boilers. Shutting down either building during the winter will be possible if the leaks in the steam system are fixed.

The second possible configuration is to keep the gas streams from each boiler separate from each other. In this case no dampers will be required, but each boiler will require its own 45 to 50 foot tall, roof mounted stack. The stack will require local roof reinforcement on each building. Alternatively, the stack can be ground supported if the roof modifications are too expensive. From an operating and maintenance view this is the more desirable configuration since the operation of one boiler does not impact the other.

CONSTRUCTION COST ESTIMATE

Project:	Install economizers on boilers in Bldg.34-140	RS&H No.:	694-1331-004
Location:	Pine Bluff Arsenal, AR	Date:	8/15/96
Basis:	Schematic Design	Estimator:	GWF
ECO Number:	H4-C	Filename:	EST-H4CF.XLS

ITEM DESCRIPTION	QUANTITY No.	QUANTITY Unit	MATERIAL/EQUIP $/Unit	MATERIAL/EQUIP Total	LABOR $/Unit	LABOR Total	TOTAL COST	SOURCE Material	SOURCE Labor
Bulk Asbestos Removal	960	SF	0.69	662	5.72	5,486	6,148	MMp 23	MMp 23
Decontam. chamber	100	SF	2.12	212	1.44	144	356	MMp 23	MMp 23
Collect and bag asbestos	106	Bag	1.2	127	4.58	484	611	MMp 24	MMp 24
Containerize full bags	106	Ea	2.42	256	2.29	242	498	MMp 24	MMp 24
Asbestos disposal	12	CY		0	160	1,877	1,877		MMp 24
Demolition duct & plenum	2.27	Ton		0	485	1,100	1,100		MMp 21
Boiler Economizer	3	ea	18000	54,000	5000	15,000	69,000	Vendor	Vendor
Peripheral equipment; pipe, valves, controls, etc.	3	ea	4500	13,500	1250	3,750	17,250	Use 25%	Use 25%
Stack, 28" dia. (50 ft each)	150	L.F.	139	20,850	21.5	3,225	24,075	MMp 246	MMp 246
Elbow, 28" dia., 90°, fixed	3	Ea	825	2,475	43	129	2,604	MMp 246	MMp 246
Structural support	4500	lb	0.95	4,275	0.36	1,620	5,895	MMp 54	MMp 54
Roof flashing, 28" dia.	3	Ea	259	777	63	189	966	MMp 244	MMp 244
Repair/replace roofing	270	SF	0.95	257	1.53	413	670	MRp 272	MRp 272
Hoist, truck mounted, 12 ton	1	Wk	2107	2,107	1070	1,070	3,177	MMp 15	MMp 475
Subtotal Bare Costs				99,498		34,729	134,227		
Retrofit Cost Factors			10%	9,950	16%	5,557	15,507	MMp6	MMp6
Subtotal				109,448		40,286	149,734		
City Cost Index			0.952	(5,254)	0.632	(14,825)	(20,079)	MMp533	MMp533
Subtotal				104,194		25,461	129,655		
OH & Profit Markups			10%	10,419	53%	13,494	23,913	MMp7	MMp475
Subtotal				114,613		38,955	153,568		
State Sales Taxes			4.5%	5,158		N.A.	5,158	MMp476	
Subtotal				119,771		38,955	158,726		
Contingency			10%	11,977	10%	3,896	15,873	MEp6	MEp6
Total Construction Cost				**131,748**		**42,851**	**$174,599**		
Design Fee				N.A.	6.0%	10,476	10,476		
SIOH				N.A.	6.0%	10,476	10,476		
Total Project Cost				**131,748**		**63,803**	**$195,551**		

LEGEND:

MEp###	1996 Means Electrical Cost Data, page ###.
MMp###	1996 Means Mechanical Cost Data, page ###.
MRp###	1991 Means Repair and Remodling Cost Data, page ###, exclated at 3%/yr.
Vendor	Vendor estimate, see attached telephone call confirmation.

A.5.H4-12

9/96

PINE BLUFF ARSENAL

Annual Energy Consumption in Production Area Boiler Buildings

1995 Energy Use Data (from boiler operating logs)

Area 32 Nat Gas Consumption (MBtu/yr) = 163,392

Area 33 Nat Gas Consumption (MBtu/yr) = 125,255

Area 34 Nat Gas Consumption (MBtu/yr) = 203,467

1995 Natural Gas Consumption in 32, 33 & 34 Boilers

Total Consumption (MBtu/yr) = Sum of Areas 32, 33 and 34

Total Consumption = 163,392 + 125,255 + 203,467

Total Consumption = 492,114 MBtu/yr

Percent Share of Total for Each Area

Area 32 = 163,392 / 492,114 = 33%

Area 33 = 125,255 / 492,114 = 25%

Area 34 = 203,467 / 492,114 = 41%

Energy Loss From Steam Leaks

Estimated energy loss due to steam leaks (1995) = 168,000 MBtu/yr

Estimated Energy Consumption w/o Steam Leaks

Forcast Consumption = Total Consumption for 1995 - Steam Leaks for 1995

= 492,114 - 168,000

= 324,114 MBtu/yr

Forcast Area Energy Consumption

Forcast area 32 = 324,114 × 33% =107,613 MBtu/yr

Forcast area 33 = 324,114 × 25% = 82,495 MBtu/yr

Forcast area 34 = 324,114 × 41%= 134,007 MBtu/yr

B#-CALC.XLS tab all

9/96

Determination of Average Annual boiler efficiency

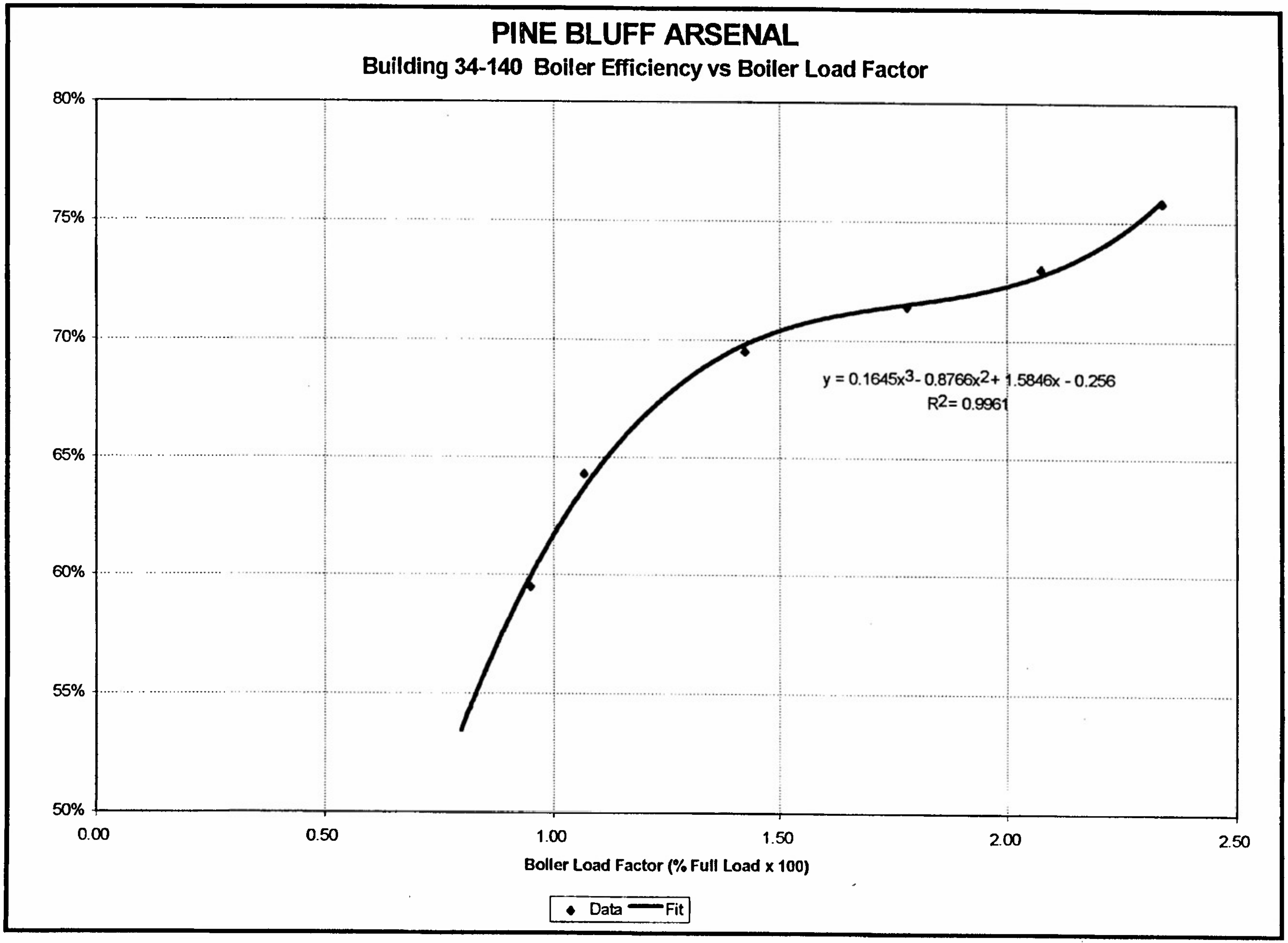
To determine the average annual boiler efficiency, stack gas analysis data was taken at five different boiler loads. The five load points ranged between the boiler's published 100% and 200% capacity because that is the range where the boiler typically operates . A curve was then drawn through the data points.

A monthly load factor was calculated from boiler operating logs. An annual average load factor was calculated from the monthly data and used to select an annual average boiler efficiency. The table below summarizes the results:

Building	Average Annual Load factor (1)	Average Annual Efficiency (2)
32-060	110%	74%
33-060	125%	75%
34-140	160%	72%

(1) Calculated from boiler operating logs. Boilers usually operate between 100% and 200% of published boiler capacity.

(2) Average annual efficiency of the boilers determined from attached graph at the average annual load factor.


PINE BLUFF ARSENAL
Building 34-140 Boiler Efficiency vs Boiler Load Factor
80%
75%
70%
65%
60%
55%
50%
0.00
0.50
1.00
1.50
2.00
2.50
Boiler Load Factor (% Full Load x 100)
y = 0.1645x3 - 0.8766x2 + 1.5846x - 0.256
R2 = 0.9961
Data
Fit

9/96

RS&H

SUBJECT PBA ELEC & HTG STUDY
O & M SAVINGS
DESIGNER W. TODD
CHECKER

AEP NO 694-1331-004
SHEET ____ OF ____
DATE 6-25-96
DATE

Boiler & Compressor Maintenance Savings

The new boilers and compressors will have fully automatic control systems which will free up the operators to perform other tasks. Currently there are 3 operators during the day shift and one operator during the two night shifts. The operators must manually adjust the boilers and compressors to match the load.

With the new boilers and compressors, one day shift operator can be transfered to another position. Using a rate of \$15 per hour the annual savings are:

$$\text{Total Savings} = \$15/\text{hr} \times 2080\ \text{hr}/\text{YR} = \$31{,}200/\text{YR}$$

Assuming the time the operator spent was distributed as follows: 80% Boilers, 20% Compressors.

$$\text{Boiler Savings} = \$31200 \times 0.8 = \$24960/\text{YR}$$

$$\text{Compressor Savings} = \$31200 \times 0.2 = \$6240/\text{YR}$$

Assuming the operators time is equally split among all boilers and compressors - the savings per boiler house is:

$$\text{Boiler Savings} = \$24960/3 = \underline{\$8{,}320/\text{YR}}$$

$$\text{Compressor Savings} = \$6240/3 = \underline{\$2080/\text{YR}}$$

RS&H®

Telephone Call Confirmation

Project Number 694-1331-004

Local ______ L.D. X Placed X Rec'd ______ Date 6-4-96

Conversed with MARK CUTTER Of McCAIN ENGINEERING
PELHAM ALABAMA.

Regarding ECONOMIZER FOR YORK SHIPLEY BOILER

MAT'L COST ≈ $18,000 CIRCULAR ECONOMIZER

INSTALLATION ≈ $5000 BECAUSE NOT RETROFIT IF

INSTALLED DURING CONSTRUCTION

George Fallon, III

Distribution:

A.5.E4-17

9/96

06/26/96 13:25 ☎ 001/001

IEC
since 1939

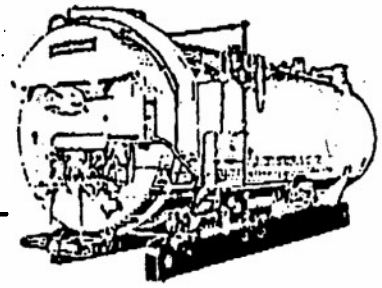
ILLINGWORTH ENGINEERING COMPANY

6855 Phillips Parkway Drive South • Jacksonville, Florida 32256

904/262-4700 • FAX 904/262-4604

manufacturers agent

FAX TRANSMITTAL



DATE: 6/26/96

TO:

ATTN: [redacted]

FAX NO: 279 -2489

FROM: CHUCK STRACENER

PAGES: 1 (Including Cover Sheet)

RE:

MESSAGE:

1EA 3/4 JACKSHAFT KIT P/N 880-339

$527.82

IF YOU DID NOT RECEIVE ALL THE PAGES, PLEASE CALL BACK AS SOON AS POSSIBLE.

A.5.F4-18

9/96

RS&H

Telephone Call Confirmation

Project Number ______

Local X L.D. ______ Placed X Rec'd ______ Date 6-27

Conversed with MIKE FLETCHALL Of ILLINGWORTH ENGINEERING

Regarding PBA 34-140 D.A. PRICING

1 - 900gal DA TANK MO. NO. SM45-900 - $19600

1 - 10' TALL TANK STAND $5,000

George Fallon III

Distribution:

9/96

ECO-C1

Utilize the surplus Gardner-Denver Compressors.

Option A - Replace two existing compressors with the surplus compressors.

Option B - Add the surplus compressors in line with existing compressors.

RS&H

SUBJECT PBA ELEC & HTG STUDY
AEP NO 694 1331 004
SHEET ____ OF ____
DESIGNER W. TODD
DATE 6-25-96
CHECKER ____
DATE ____

ECO - C1 UTILIZE SURPLUS COMPRESSORS

Assumptions:
1) Existing compressors use 0.18 kw/cfm See calculations attached.
2) Surplus compressors use 0.20 kw/cfm See calculations attached.
3) O&M savings will be \$2080/YR with the surplus compressors. See attached.
4) The surplus compressors will only operate during production hours = 2080 hr/YR

Energy Savings =

$$\left(\text{Existing kw/cfm} - \text{New kw/cfm}\right) \times 600\ \text{cfm} \times 2 \times 2080\ \text{hr/YR}$$

$$= \left(0.18 - 0.20\right) \frac{\text{kw}}{\text{cfm}} \times 1200\ \text{cfm} \times 2080\ \text{hr/YR}$$

$$\text{Energy Savings} = -49920\ \text{kwh/YR} \times 3413 \frac{\text{Btu}}{\text{kw}} \times \frac{1\ \text{mBtu}}{10^6\ \text{Btu}}$$

$$\text{Energy Savings} = -170.4\ \text{mBtu/YR}$$

negitive savings because surplus units use more energy than existing.

$$\text{Cost increase} = -170.4 \frac{\text{mBtu}}{\text{YR}} \times \$16.79/\text{mBtu} = \underline{\$-2{,}861/\text{YR}}$$

Net Operating Cost Savings or increase:

$$\$2080 - \$2861 = \underline{-\$781/\text{year}}$$

There is a net cost increase.

ECO CALCULATIONS
Compressor Energy Efficiency

Project:	Install More Efficient Compressors		RSH No.:	6941331004
Location:	Pine Bluff Arsenal, AR		Date:	6/25/96
ECO No.:	C2		Designer:	W. Todd

Compressor Mfg.: Ingersoll-Rand Model: XLE

Assumptions:	(1)	Compressor air supply rate =		825 cfm	(Name plate data)
	(2)	Motor data:	Horsepower:	173	(Name plate data)
			Efficiency:	90%	(Est., Marks' p. 15-49)
			Volts:	460	(Name plate data)
			Amps:	206	(Name plate data)
			Phases:	3	(Name plate data)
			Power Factor:	0.80	(Est., Marks' p. 15-49)

$$\text{Maximum motor kW} = \frac{460 \text{ V} \times 206 \text{ A} \times 1.73 \times 0.8}{0.90 \times 1000} = 145.9 \text{ kW}$$

$$\text{Full Load Compressor Efficiency} = \frac{145.9 \text{ kW}}{825 \text{ cfm}} = 0.177 \text{ kW / cfm}$$

C2-CALC.XLS

A.5.C1-3

ECO CALCULATIONS
Compressor Energy Efficiency

Project:	Install More Efficient Compressors	RSH No.:	6941331004
Location:	Pine Bluff Arsenal, AR	Date:	6/25/96
ECO No.:	C2	Designer:	W. Todd

Compressor Mfg: Gardner Denver Model: MCY-MH

Assumptions:	(1)	Compressor air supply rate =		600 cfm	(Mfg. submittal data)
	(2)	Motor data:	Horsepower:	150	(Mfg. submittal data)
			Efficiency:	96.2%	(Granger Cat. No. 386)
			Volts:	460	(Mfg. submittal data)
			Amps:	168	(Mfg. submittal data)
			Phases:	3	(Mfg. submittal data)
			Power Factor:	0.85	(C/S Engineer Article)

$$\text{Maximum motor kW} = \frac{460\ \text{V} \times 168\ \text{A} \times 1.73 \times 0.85}{0.96 \times 1000} = 118.3\ \text{kW}$$

$$\text{Full Load Compressor Efficiency} = \frac{118.3\ \text{kW}}{600\ \text{cfm}} = 0.197\ \text{kW / cfm}$$

RS&H

SUBJECT PBA ELEC & HTG STUDY
O & M SAVINGS
DESIGNER W. TODD
CHECKER

AEP NO 694-1331-004
SHEET OF
DATE 6-25-96
DATE

Boiler & Compressor Maintenance Savings

The new boilers and compressors will have fully automatic control systems which will free up the operators to perform other tasks. Currently there are 3 operators during the day shift and one operator during the two night shifts. The operators must manually adjust the boilers and compressors to match the load.

With the new boilers and compressors, one day shift operator can be transfered to another position. Using a rate of \$15 per hour the annual savings are:

Total Savings = \$15/hr × 2080 hr/YR = \$31,200/YR

Assuming the time the operator spent was distributed as follows: 80% Boilers, 20% Compressors,

Boiler Savings = \$31200 × 0.8 = \$24960/YR

Compressor Savings = \$31200 × 0.2 = \$6240/YR

Assuming the operators time is equally split among all boilers and compressors - the savings per boiler house is:

Boiler Savings = \$24960/3 = \$8,320/YR

Compressor Savings = \$6240/3 = \$2080/YR

ECO-C2

Replace the existing compressors with more efficient compressors.

RS&H

Reynolds, Smith and Hills, Inc.
Architectural, Engineering, Planning and Environmental Services

Telephone Call Confirmation

Date: April 25, 1996

Project Number: 694-1331-004

Project Name: PBA Elec. & Heating Study

Received: **Placed:** by W. T. Todd

Local: **Long Dist.:** 305-888-8978

Conversed with: Paul Edwards

of Arle Compressor Systems (sell/service/install/consult - Miami, FL)

Regarding: Energy savings opportunities for compressors.

I asked Paul if a new compressor would be more energy efficient than the existing Ingersoll-Rand Model XLE compressors. The XLE is the most efficient compressor ever made for air flow rates of less than about 3000 cfm. Their resale value is excellent. They do not sell them anymore because it is too expensive to manufacture them. He estimated the output for these compressors to be approximately 700 to 750 cfm at 125 psig. As long as you use a synthetic lubricant in the XLE's they will last for many more years. You can sometimes justify new compressors based on water savings but they use very inexpensive filtered water at PBA. Other suggestions for energy savings options are:

Multiplex Air Dryers: Manufactured by ZEKS. These dryers turn on and off based on demand. Typical dryers are always on regardless of the load. Cost would be about $40,000 to $50,000. Contact at ZEKS is Alex Mazander, 501-851-3051 (fax -1405).

Self Cleaning Filters: The Mist Eliminator mfg by ZEKS has a 1 psi pressure drop and lasts for 10-15 years (or more). Typical filters have a 3 to 9 psi pressure drop. Power requirements are about 0.5% HP per psi. Cost would be about $7,000 for 4500 cfm.

Intermediate Controller: Stabilizes the air pressure leaving the compressor houses. Rep is Conserve Air, contact Bill Holifield at 904-786-7170.

Distribution: PBA File

By: William T. Todd, PE

A.5.C2-2

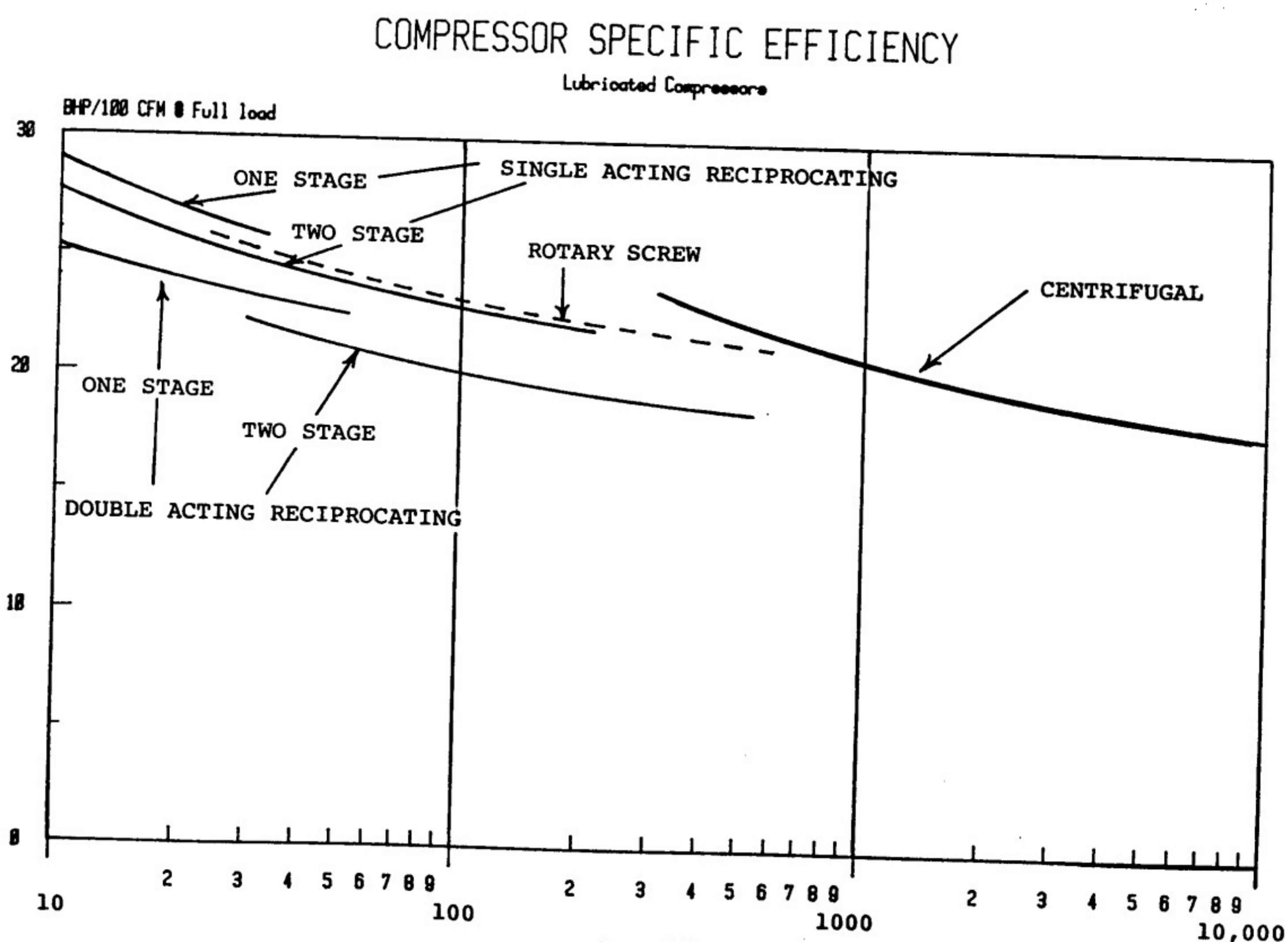


Figure 4-1 Relative Full Load Power Required of Typical Lubricated Compressors, 100 psig, at Sea Level

A.5.C2-3

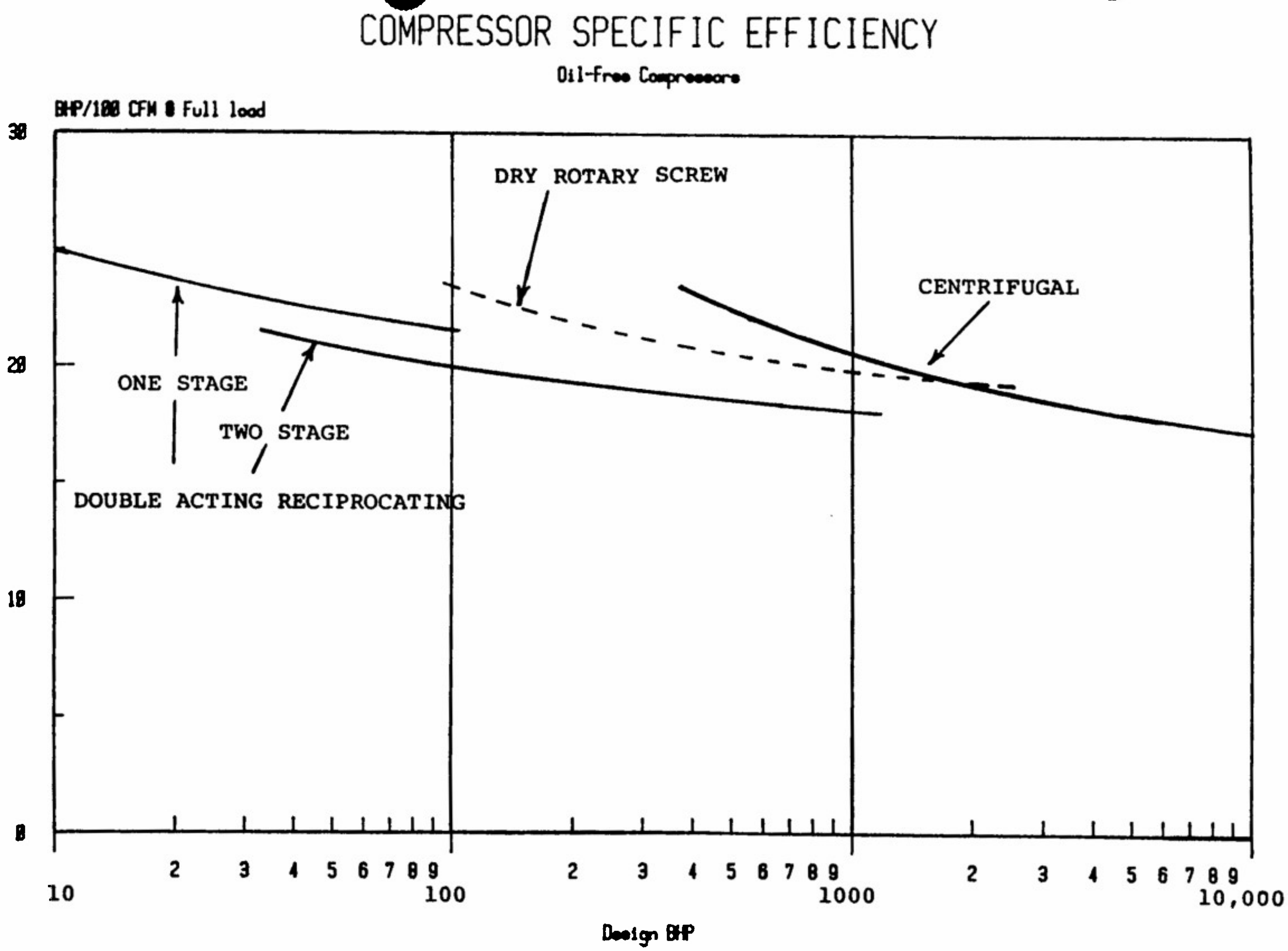


Figure 4-2 Relative Full Load Power Required of Typical Oil-Free Compressors, 100 psig, at Sea Level

A.5.C2-4

COMPRESSOR OPERATIONAL EFFICIENCY

Compressor/Control Combinations

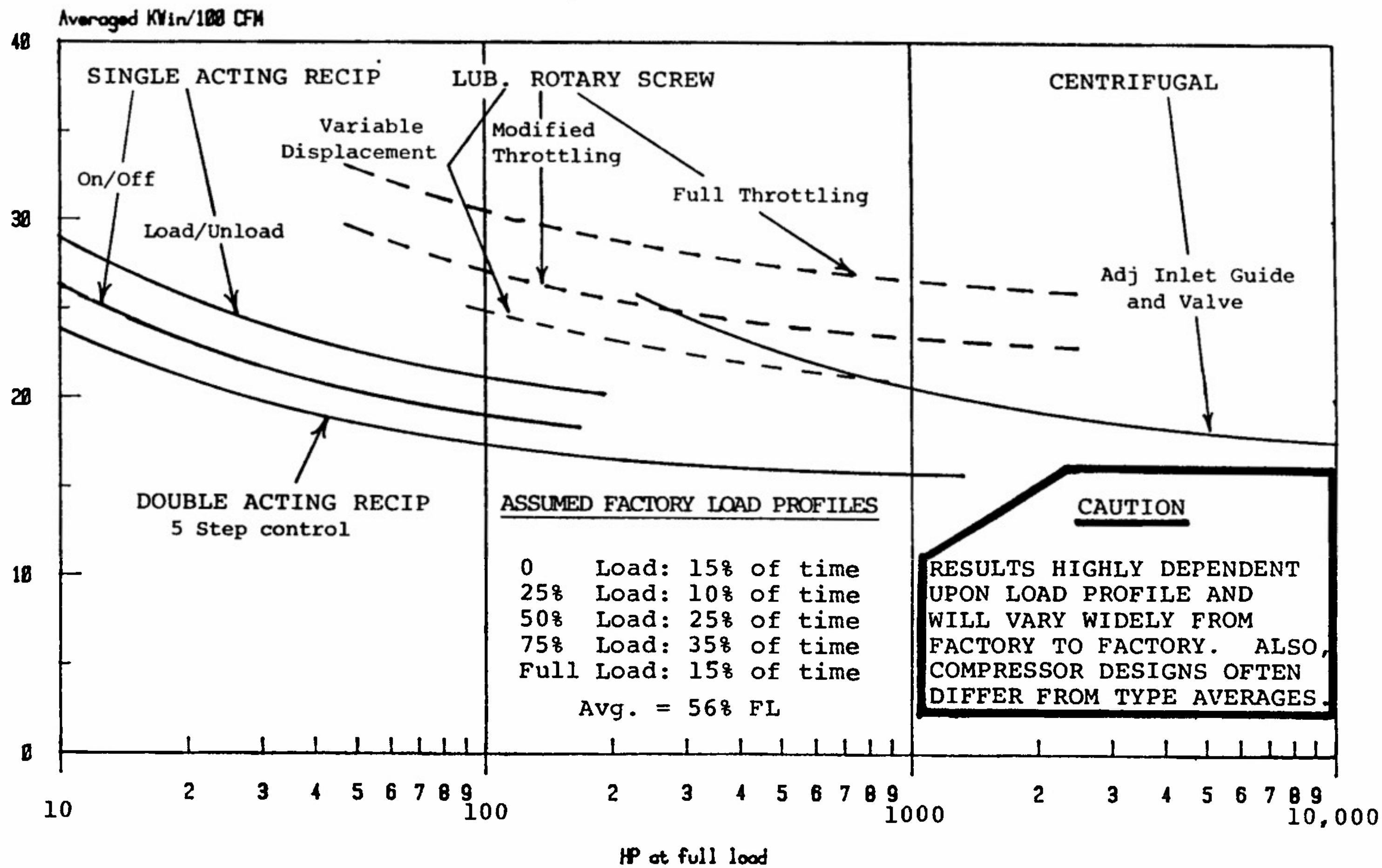


Figure 4-3 Relative Power Required by Single Compressor Supplying Variable Load, 100 psig , Sea Level

A.5.C2-5

ECO CALCULATIONS
Compressor Energy Efficiency

Project:	Install More Efficient Compressors	RSH No.:	6941331004
Location:	Pine Bluff Arsenal, AR	Date:	6/25/96
ECO No.:	C2	Designer:	W. Todd

Compressor Mfg.: Ingersoll-Rand   Model: XLE

Assumptions:	(1)	Compressor air supply rate =		825 cfm	(Name plate data)
	(2)	Motor data:	Horsepower:	173	(Name plate data)
			Efficiency:	90%	(Est., Marks' p. 15-49)
			Volts:	460	(Name plate data)
			Amps:	206	(Name plate data)
			Phases:	3	(Name plate data)
			Power Factor:	0.80	(Est., Marks' p. 15-49)

$$\text{Maximum motor kW} = \frac{460\ \text{V} \times 206\ \text{A} \times 1.73 \times 0.8}{0.90 \times 1000} = 145.9\ \text{kW}$$

$$\text{Full Load Compressor Efficiency} = \frac{145.9\ \text{kW}}{825\ \text{cfm}} = 0.177\ \text{kW / cfm}$$

A.5.C2-6

ECO CALCULATIONS
Compressor Energy Efficiency

Project:	Install More Efficient Compressors		RSH No.:	6941331004
Location:	Pine Bluff Arsenal, AR		Date:	6/25/96
ECO No.:	C2		Designer:	W. Todd

Compressor Mfg: Gardner Denver Model: MCY-MH

Assumptions:	(1)	Compressor air supply rate =		600 cfm	(Mfg. submittal data)
	(2)	Motor data:	Horsepower:	150	(Mfg. submittal data)
			Efficiency:	96.2%	(Granger Cat. No. 386)
			Volts:	460	(Mfg. submittal data)
			Amps:	168	(Mfg. submittal data)
			Phases:	3	(Mfg. submittal data)
			Power Factor:	0.85	(C/S Engineer Article)

$$\text{Maximum motor kW} = \frac{460 \text{ V} \times 168 \text{ A} \times 1.73 \times 0.85}{0.96 \times 1000} = 118.3 \text{ kW}$$

$$\text{Full Load Compressor Efficiency} = \frac{118.3 \text{ kW}}{600 \text{ cfm}} = 0.197 \text{ kW / cfm}$$

ELECTRIC MOTOR DATA SHEET

Survey Date: 3/27 & 1/30/96; Survey By: WTT / CSW

Equipment ID/Function: Compressor No. 4

Location: Bldg. 34 140

Nameplate Data:

Manufacturer: General Electric

Model No.: 5SR 684 A60 ; Serial No.: DE 837 1527

Insulation Class: ____; NEMA Design: ____; Code: A; Efficiency: ____

Horsepower 173; Frame 965Y; RPM 600; Service Factor ____

Volts 460; Amps 206; Phases 3; Hz 60; PF 0.8; kW ____

Type: Synchronous ✓; Induction ____; Other TYPE TS

For Synchronous Motors: DC Excitation Volts 125; Amps 33

Electrical Measurements: ← CSW → | ← WTT →

Measurements	Phase 1	Phase 2	Phase 3	Phase	Phase 1-2	Phase 2-3
Volts(rms)	478.6	4.15	483.1		511.1	502.6
Amps(rms)	176.6	191.0	195.1		168.8	185.5
kW	86.12	-0.38	51.58		89.95	36.61
kVAR	1.77 LE	0.65 LA	80.07 LE		2.73 LE	80.29 LE
kVA	86.16	0.76	95.27		90.02	88.27
Power Factor	0.99	-0.5	0.54		0.99	0.41
dPF	0.99	-0.5	0.54		0.99	0.41
kdVA	2.010	44.43	1.995		2.092	2.103

General Condition/Comments: Motor Control Panel Readings:
169 Amps AC ; 34.5 Amps DC

AIR COMPRESSOR DATA

Survey by: GWF / WTT Date: 3/27/96
Maintenance Name: Phone:
Building Number: 34-140 Compressor I.D. No.: 3
Service area or Loads:

Compressor Specifications:
Mfg. & Model #: IR, TYPE XLE, MODEL 16-10×7
Type: Recip.: ✓ Cent.: Other: Date = 1967 SN JH4199
Capacity (cfm): 825 Operating Pressure (psig): 130
Electric Motor:
Type: Synchronous ✓ Induction: Other:
Volts: 460 Amps: 192 Phases: 3 Hz: 60 RPM: 600
HP: 150 Mfg: GE Model No.: 5SR 684 A52

Operation Schedule: hr/da: 24 da/wk: 7 mn/yr: 12
Cooling Method: Air: Water: ✓
Air Source Location: Outdoors: ✓ Other:
Control System: Pneumatic staging control - 2 stages
Manual on/off control.

Maintenance Schedule: As required, no PM

O&M log available: Yes No Copies Obtained: Yes No

Auxiliary Equipment: (Air Dryer, Heat Recovery, etc.)
Air dryer disconnected

Heat Recovery Potential: (Accessibility, heat load nearby) Use cooling water to preheat boiler feedwater? ~25°F ΔT

General Condition/Comments/Problems: GE 150 HP, PF = 0.8, 153 KVA
440 V, 201 A 600 RPM

EXI, V = 125 A = 34.6
ARM AMPS = 216 AT SF = 1.15

MODEL 5SR 684 A52
SN BC8370155

PANEL AC AMPS = 128
DC AMPS - NOT WORKING

A.5.C2-9

AIR COMPRESSOR DATA

Survey by: GWF / WTT Date: 3/27/96
Maintenance Name: Phone:
Building Number: 34-140 Compressor I.D. No.: 4
Service area or Loads: Area 3 Section 4 and Sections 1, 2 and 3 via header piping system.

Compressor Specifications:
Mfg. & Model #: INGERSOLL-RAND, TYPE XLE, MODEL 16-10x7
Type: Recip.: ✓ Cent.: Other: Date = 1967 SN: JH4868
Capacity (cfm): 825 Operating Pressure (psig): 130

Electric Motor:
Type: Synchronous ✓ Induction: Other:
Volts: 460 Amps: 206 Phases: 3 Hz: 60 RPM: 600
HP: 173 Mfg: GE Model No.: 5SR684A60

Operation Schedule: hr/da: 24 da/wk: 7 mn/yr: 12
Cooling Method: Air: Water: ✓
Air Source Location: Outdoors: ✓ Other:
Control System: Pneumatic staging control - 2 stages
Manual on/off control.

Maintenance Schedule: as required, no PM

O&M log available: Yes No Copies Obtained: Yes No

Auxiliary Equipment: (Air Dryer, Heat Recovery, etc.)
Air dryer disconnected.

Heat Recovery Potential: (Accessibility, heat load nearby) Use cooling water to preheat boiler feed water? ~25°ΔT

General Condition/Comments/Problems: PANEL { AC Amps = 169
DC Amps = 345 }

A.5.C2-10

Table 15.1.14 Performance Data for Coupled Synchronous Motors

hp	Poles	r/min	A	Excitation, kW	Efficiencies, percent: ½ load	Efficiencies, percent: ¾ load	Efficiencies, percent: Full load	Weight, lb
Unity power factor, 3 phase, 60 Hz, 2,300 V								
500	4	1,800	100	3	94.5	95.2	95.3	5,000
2,000	4	1,800	385	9	96.5	97.1	97.2	15,000
5,000	4	1,800	960	13	96.5	97.3	97.5	27,000
10,000	6	1,200	1,912	40	97.5	97.9	98.0	45,000
500	18	400	99.3	5	92.9	93.9	94.3	7,150
1,000	24	300	197	8.4	93.7	94.6	95.0	15,650
4,000	48	150	781	25	94.9	95.6	95.6	54,000
80% power factor, 3 phase, 60 Hz, 2,300 V								
500	4	1,800	127	4.5	93.3	94.0	94.1	6,500
2,000	4	1,800	486	13	95.5	96.1	96.2	24,000
5,000	4	1,800	1,212	21	95.5	96.3	96.5	37,000
10,000	6	1,200	2,405	50	96.8	97.3	97.4	70,000
500	18	400	125	7.2	92.4	93.4	93.6	9,500
1,000	24	300	248	11.6	93.3	94.2	94.4	17,500
4,000	48	150	982	40	94.6	95.3	95.5	11,500

SOURCE: Westinghouse Electric Corp.

loss, the disk follows the field just as the rotor of an induction motor does. When the rotor approaches the synchronous speed of 3,600 r/min, the rotating magnetic field takes a path along the two rotor bars and locks the rotor in with it. The rotor and the necessary train of reducing gears rotate in oil sealed in a

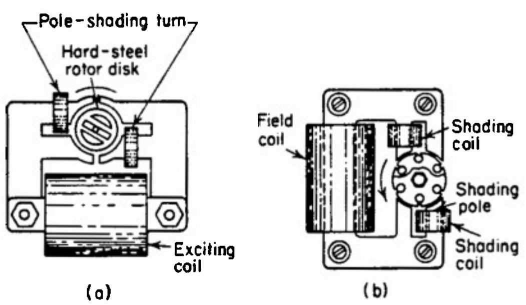


Fig. 15.1.74 Synchronous motors for timing. (*a*) Warren Telechron motor; (*b*) Holtz induction-reluctance subsynchronous motor.

small metal can. Figure 15.1.74*b* shows a subsynchronous motor. Six squirrel-cage bars are inserted in six slots of a solid cylindrical iron rotor, and the spaces between the slots form six salient poles. The motor, because of the squirrel cage, starts as an induction motor, attempting to attain the speed of the rotating field, or 3,600 r/min (at 60 Hz). However, when the rotor reaches 1,200 r/min, one-third synchronous speed, the salient poles of the rotor lock in with the poles of the stator and hold the rotor at 1,200 r/min.

AD-DC CONVERSION

Static Rectifiers

Silicon devices, and to a lesser extent gas tubes, are the primary means of ac to dc or dc to ac conversion in modern installations. They are advantageous when compared to synchronous converters or motor generators because of efficiency, cost, size, weight, and reliability. Various bridge configurations for single-phase and three-phase applications are shown in Fig. 15.1.75*a*. Table 15.1.15 shows the relative outputs of rectifier circuits. The use of two three-phase bridges fed from an ac source consisting of a three-winding transformer with both a Δ and Y secondary winding so that output voltages are 30° out of phase will reduce dc ripple to approximately 1 percent.

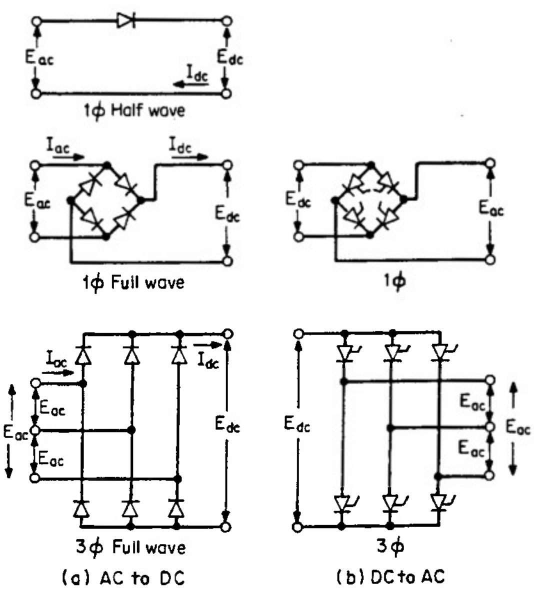


Fig. 15.1.75 AC-DC conversion with static devices.

A.5.C2-11

Price $ 5.00

13-6-611
1st Edition

GARDNER-DENVER®

MODELS: MCYA_B
MCYE_B
MCYK_B
MCYM_B

COMPRESSORS FOR INDUSTRIAL SERVICE

COMPRESSOR SERIAL NO. PA-610 GB-602 PA-611 GB-603

COMPRESSOR MODEL NO. MCYMH

SIZE 14 3/4" & 8 1/2" x 5

600 cfm

13-6-611

Operating and Service Manual

COOPER INDUSTRIES

INDUSTRIAL MACHINERY

A.5.C2-12

CUSTOMER JOHN BROWN /ARMY SHEET 1 OF 4 REV ____ DATE ____ ☒ M.T.RS

CUSTOMER P.O.# PB-0303-0056 MAT'L. REQ'D. BY 6/16/89 REV ____ DATE ____ ☒ CERT. OF C

B/M FOR 1 UNITS 2 REQ'D. NDR. LIT. REQ'D. 38 REV ____ DATE ____ ☐ CERT. OF T

ITEM-CODE	QUAN.	DESCRIPTION	SP	REV	PO NBR	SUPPLIER	REC.	PART NBR.
1-2	1	GARDNER DENVER MODEL MCYMH			MCYM-H			
		14 3/4" x 8 1/2 x 5" NON LUBE AIR						
		COMPRESSOR W/INTERCOOLER &						
		SHEAVE						
2-2	1	SIEMENS MOTOR 150 HP, 1800 RPM						
		460/3/60 1.15 SF HIGH EFF.						
		TEFC 445T FRAME						
3-2	1	SLIDE BASE FOR 445-T FRAME						
		MOTOR WITH 2 TENSIONING BOLTS						
4-2	1	BASCO MODEL 05084 AFTERCOOLER						
		TEMA C' DESIGN - ASME						
5-2	1	SOLBERG (OR EQUAL) MODEL						
		FS-274P-600 W/6" FLANGE						
		CONN. AND PAPER ELEMENT						
		AND WEATHER HOOD						
6-2	1	DAYTON FLEX HOSE STOCK NO.						
		4Z490 3" 150# FLANGE CONN.						

A.5.C2-13

ECO-C3

Modifications and improvements to the compressed air system.

Option A - Install dedicated compressors at the end use buildings.

Option B - Install new compressed air distribution piping.

Option C - Repair existing compressed air pipe and fittings.

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-C3
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: P B ARSENAL REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: ECO-C3 COMPRESSED AIR SYSTEM MODIFICATIONS
FISCAL YEAR 1997 DISCRETE PORTION NAME: OPTION A - DEDICATED COMP S
ANALYSIS DATE: 07-02-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

A. CONSTRUCTION COST	$ 1320276.		
B. SIOH	$ 79217.		
C. DESIGN COST	$ 79217.		
D. TOTAL COST (1A+1B+1C)	$ 1478710.		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F. PUBLIC UTILITY COMPANY REBATE		$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 1478710.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 16.79	5061.	$ 84973.	15.08	$ 1281386.
B. DIST	$ .00	0.	$ 0.	18.57	$ 0.
C. RESID	$ .00	0.	$ 0.	21.02	$ 0.
D. NAT G	$ 2.81	0.	$ 0.	18.58	$ 0.
E. COAL	$ .00	0.	$ 0.	16.83	$ 0.
F. PPG	$ .00	0.	$ 0.	17.38	$ 0.
M. DEMAND SAVINGS			$ 0.	14.88	$ 0.
N. TOTAL		5061.	$ 84973.		$ 1281386.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 0.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 84973.

5. SIMPLE PAYBACK PERIOD (1G/4) 17.40 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 1281386.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= .87
(IF < 1 PROJECT DOES NOT QUALIFY)

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: ECO-C3
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID FY95 (92)
INSTALLATION & LOCATION: P B ARSENAL REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: ECO-C3 COMPRESSED AIR SYSTEM MODIFICATIONS
FISCAL YEAR 1997 DISCRETE PORTION NAME: OPTION B - REPLACE CA PIPING
ANALYSIS DATE: 07-02-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

A. CONSTRUCTION COST	$ 1240301.		
B. SIOH	$ 74418.		
C. DESIGN COST	$ 74418.		
D. TOTAL COST (1A+1B+1C)	$ 1389137.		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F. PUBLIC UTILITY COMPANY REBATE		$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 1389137.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 16.79	5847.	$ 98176.	15.08	$ 1480497.
B. DIST	$ .00	0.	$ 0.	18.57	$ 0.
C. RESID	$ .00	0.	$ 0.	21.02	$ 0.
D. NAT G	$ 2.81	0.	$ 0.	18.58	$ 0.
E. COAL	$ .00	0.	$ 0.	16.83	$ 0.
F. PPG	$ .00	0.	$ 0.	17.38	$ 0.
M. DEMAND SAVINGS			$ 0.	14.88	$ 0.
N. TOTAL		5847.	$ 98176.		$ 1480497.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ 0.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 98176.

5. SIMPLE PAYBACK PERIOD (1G/4) 14.15 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 1480497.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 1.07
(IF < 1 PROJECT DOES NOT QUALIFY)

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: ECO-C3
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID FY95 (92)
INSTALLATION & LOCATION: P B ARSENAL REGION NOS. 6 CENSUS: 3
PROJECT NO. & TITLE: ECO-C3 COMPRESSED AIR SYSTEM MODIFICATIONS
FISCAL YEAR 1997 DISCRETE PORTION NAME: OPTION C - REPAIR CA PIPING
ANALYSIS DATE: 07-02-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

A. CONSTRUCTION COST	$ 74718.		
B. SIOH	$ 4483.		
C. DESIGN COST	$ 4483.		
D. TOTAL COST (1A+1B+1C)	$ 83684.		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F. PUBLIC UTILITY COMPANY REBATE		$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 83684.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 16.79	5847.	$ 98176.	15.08	$ 1480497.
B. DIST	$ .00	0.	$ 0.	18.57	$ 0.
C. RESID	$ .00	0.	$ 0.	21.02	$ 0.
D. NAT G	$ 2.81	0.	$ 0.	18.58	$ 0.
E. COAL	$ .00	0.	$ 0.	16.83	$ 0.
F. PPG	$ .00	0.	$ 0.	17.38	$ 0.
M. DEMAND SAVINGS			$ 0.	14.88	$ 0.
N. TOTAL		5847.	$ 98176.		$ 1480497.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 0.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 98176.

5. SIMPLE PAYBACK PERIOD (1G/4) .85 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 1480497.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 17.69
(IF < 1 PROJECT DOES NOT QUALIFY)

RS&H

SUBJECT PBA ELEC & HTG STUDY
DEDICATED COMPRESSORS
DESIGNER W. TODD
CHECKER

AEP NO 694-1331-004
SHEET ____ OF ____
DATE 6-25-96
DATE

ECO-C3-A, INSTALL DEDICATED COMPRESSORS

Compressed Air Demand:

Bldg. No.	CFM Req'd (1)	No. Compressors Req'd. 10 cfm	100 cfm	200 cfm	600 cfm
31530	200 cfm			1	
31620	200			1	
31630	1800				3
31640	10	1			
31720	10	1			
Subtotals	2220	2	0	2	3
32070	10	1			
32230	400			2	
32270	1800				3
32610	100		1		
32620	178			1	
32640	1200				2
Subtotals	3688	1	1	3	5
33530	2100		1	1	3
33620	10	1			
33670	600				1
Subtotals	2710	1	1	1	4
34110	600				1
34630	120			1	
34640	100		1		
Subtotals	820	0	1	1	1
Totals	9,438 cfm	4	3	7	13

(1) From CDG Utility Study, Exhibit G, see attached pages.

RS&H

SUBJECT PBA ELEC + HTG STUDY
DEDICATED COMPRESSORS
DESIGNER W. Todd
CHECKER

AEP NO 694 1331 004
SHEET ___ OF ___
DATE 6-25-96
DATE

ECO - C3 (continued)

According to the PBA production staff, Buildings 31620, 31630 and 31720 are in layaway. There are also 2-600 cfm compressor packages available (already purchased by DPW) to install. The 10 cfm compressors are very small and will not be considered in the cost estimate for this analysis. The number of compressors required now becomes:

100 cfm : 3 each

200 cfm : 7 - 1 (Bldg. 31620) = 6 each

600 cfm : 13 - 3 (Bldg. 31630) - 2 (surplus) = 8 each

According to the DPW operating staff: 2 to 3 of the existing 6 compressors operate during non-production times and 4 to 6 of them operate during production. The existing compressors have a rated output of 825 cfm each.

A detailed survey of the C.A. system was not included in the scope of this study, however, during the steam line survey many compressed air leaks were observed. The following assumptions / estimates will be used for the analysis of this ECO:

- The process load during non-production is ~412 cfm ($\frac{1}{2}$ compressor)
- Leaks at or inside process buildings is ~412 cfm ($\frac{1}{2}$ compressor)
- Leaks in the main distribution piping is ~1237 cfm ($1\frac{1}{2}$ compressors)

- Process air load = 5 compressors - $1\frac{1}{2}$ (main leaks) - $\frac{1}{2}$ (bldg. leaks) = 3 comp.

ECO CALCULATIONS

Project:	Install Individual Dedicated Compressors	RSH No.:	694-1331-004
Location:	Pine Bluff Arsenal, AR	Date:	6/25/96
ECO No.:	C3-A	Designer:	W. Todd

Assumptions:

1.	Number compressors operating at full load during production:		5		(estimated by operating staff)
2.	Number compressors operating at half load during production:		0		(estimated by operating staff)
3.	Number compressors operating at full load during non-production:		2		(estimated by operating staff)
4.	Number compressors operating at half load during non-production		1		(estimated by operating staff)
5.	Exist. compressors:	Design CA supply capacity:	825	cfm	(from nameplate data)
		Calculated electric demand:	145.9	kW	(from nameplate data)
		Measured electric demand:	130.7	kW	(measured during survey)
		Actual percent motor load:	0.90		(measured kW / nameplate kW)
		Demand per design supply cfm:	0.158	kW/cfm	(measured kW / design cfm)
6.	New Compressors:	Design CA supply capacity:	600	cfm	(from Gardner-Denver data)
		Electric demand at full load:	118.3	kW	(from Gardner-Denver data)
		Estimated percent motor load:	0.90		(assume same as existing)
		Estimated electric demand:	106.5	kW	(percent load x G-D data kW)
		Demand per design supply cfm:	0.178	kW/cfm	(estimated kW / design cfm)
7.	Production schedule: 10 hr/day, 4 day/wk, 52 wks/yr				
8.	Compressed air distribution:	Process buildings (production) =	60%		(Assume 3.0 comp. / 5 comp)
		Process buildings (non-prod) =	10%		(Assume 0.5 comp. / 5 comp)
		Leaks at or in buildings =	10%		(Assume 0.5 comp. / 5 comp)
		Leaks in main CA dist. piping =	30%		(Assume 1.5 comp. / 5 comp)
9.	Average cost of electric energy consumed at PBA :		$16.79	/MBtu	(calculated from electric bills)

<u>Estimate of compressed air supplied by the main system:</u>

During Production =	5	comp. x	825	cfm/co. +	0	comp. x	412.5	cfm/co. =	4125 cfm
During Non-prod. =	2	comp. x	825	cfm/co. +	1	comp. x	412.5	cfm/co. =	2063 cfm

<u>Estimate of current energy consumption:</u>

During Production =	0.158 kW/cfm	x	4125 cfm	=	651.8 kW
	651.8 kW	x	2080 hrs/year	=	1355744 kWh/yr
	1355744 kWh/yr	x	0.003413 MB/kWh	=	4627.2 MBtu/yr
During Non-prod. =	0.158 kW/cfm	x	2063 cfm	=	326.0 kW
	326.0 kW	x	6680 hrs/year	=	2177680 kWh/yr
	2177680 kWh/yr	x	0.003413 MB/kWh	=	7432.4 MBtu/yr
Total =	4627.2 MBtu/yr	+	7432.4 MBtu/yr	=	12059.6 MBtu/yr

C3-CALC.XLS

ECO-C3-A

Estimate of compressed air required at the buildings:

During Production =	4125 cfm	x	60%	+	4125 cfm	x	10%	=	2888 cfm
During Non-prod. =	4125 cfm	x	10%	+	4125 cfm	x	10%	=	825 cfm

Estimate of energy consumption after ECO implementation:

During Production =	0.178 kW/cfm x	2888 cfm	=	514.1 kW
	514.1 kW x	2080 hrs/year =		1069328 kWh/yr
	1069328 kWh/yr x	0.003413 MB/kWh=		3649.6 MBtu/yr
During Non-prod. =	0.178 kW/cfm x	825 cfm	=	146.9 kW
	146.9 kW x	6680 hrs/year =		981292 kWh/yr
	981292 kWh/yr x	0.003413 MB/kWh=		3349.1 MBtu/yr
Total =	3649.6 MBtu/yr +	3349.1 MBtu/yr =		6998.7 MBtu/yr

Estimate of annual energy and cost savings:

Energy Savings =	12059.6 MBtu/yr -	6998.7 MBtu/yr =	5060.9 MBtu/yr
Cost Savings =	5060.9 MBtu/yr x	$16.79 /MBtu =	$84,973 /Year

CONSTRUCTION COST ESTIMATE

Project:	Individual Dedicated Compressors	RS&H No.:	694-1331-004
Location:	Pine Bluff Arsenal, AR	Date:	6/25/96
Basis:	Schematic Design	Estimator:	W. Todd
ECO Number:	C3A	Filename:	EST-C3.XLS

ITEM DESCRIPTION	QUANTITY		MATERIAL/EQUIP		LABOR		TOTAL COST	SOURCE	
	No.	Unit	$/Unit	Total	$/Unit	Total		Material	Labor
Compressor system, 100cfm, installed, bare costs.	3	Ea	36085	108,255	2393	7,179	115,434	Note (1)	Note (1)
Compressor system, 200cfm, installed, bare costs.	6	Ea	40618	243,708	3130	18,780	262,488	Note (1)	Note (1)
Compressor system, 600cfm, installed, bare costs.	8	Ea	84262	674,096	6762	54,096	728,192	Note (1)	Note (1)
Subtotal Bare Costs				1,026,059		80,055	1,106,114		
Retrofit Cost Factors			0%	0	0%	0	0	MMp6	MMp6
Subtotal				1,026,059		80,055	1,106,114		
City Cost Index			0.952	(49,251)	0.632	(29,460)	(78,711)	MMp533	MMp533
Subtotal				976,808		50,595	1,027,403		
OH & Profit Markups			10%	97,681	53%	26,815	124,496	MMp7	MMp475
Subtotal				1,074,489		77,410	1,151,899		
State Sales Taxes			4.5%	48,352		N.A.	48,352	MMp476	
Subtotal				1,122,841		77,410	1,200,251		
Contingency			10%	112,284	10%	7,741	120,025	MEp6	MEp6
Total Construction Cost				**1,235,125**		**85,151**	**$1,320,276**		
Design Fee				N.A.	6.0%	79,217	79,217		
SIOH				N.A.	6.0%	79,217	79,217		
Total Project Cost				**1,235,125**		**243,585**	**$1,478,710**		

LEGEND:

MEp###	1996 Means Electrical Cost Data, page ###.
MMp###	1996 Means Mechanical Cost Data, page ###.
Note (1)	See attached detailed estimates, Subtotal Bare Costs.

CONSTRUCTION COST ESTIMATE

Project:	Individual Dedicated Compressors	RS&H No.:	694-1331-004
Location:	Pine Bluff Arsenal, AR	Date:	6/25/96
Basis:	Schematic Design	Estimator:	W. Todd
ECO Number:	C3 A	Filename:	EST-C3-1.XLS

ITEM DESCRIPTION	QUANTITY		MATERIAL/EQUIP		LABOR		TOTAL COST	SOURCE	
	No.	Unit	$/Unit	Total	$/Unit	Total		Material	Labor
Compressor, 100cfm, 100psi, water cool, 25hp motor, v-belt drive, aftercooler, separator, S-S controls, inlet filter, gages & base.	1	Ea	25654	25,654	721	721	26,375	Vendor	MMp248(1)
Dryer and Filter, 100cfm	1	Ea	6425	6,425	96	96	6,521	MMp290	MMp290
Electric motor installation, 460 V, 3 phase, 25 hp, safety switches, starter, wire, conduit & couplings.	1	Ea	855	855	925	925	1,780	MEp321	MEp321
Water piping, 1", Sched. 40, threaded, w/hangers	50	LF	2.5	125	4.54	227	352	MMp139	MMp139
Air piping, 2", Schedule 40 welded joints, w/ hangers	50	LF	5.68	284	7.1	355	639	MMp139	MMp139
Concrete Slab, 6" x 6' x 6'	0.67	CY	62.37	42	21	14	56	MMp46	MMp46
Storage Shed, 6' x 6'	36	SF	75	2,700	1.52	55	2,755	MMp11	MMp11
Subtotal Bare Costs				36,085		2,393	38,478		
Retrofit Cost Factors			0%	0	0%	0	0	MMp6	MMp6
Subtotal				36,085		2,393	38,478		
City Cost Index			0.952	(1,732)	0.632	(881)	(2,613)	MMp533	MMp533
Subtotal				34,353		1,512	35,865		
OH & Profit Markups			10%	3,435	53%	801	4,236	MMp7	MMp475
Subtotal				37,788		2,313	40,101		
State Sales Taxes			4.5%	1,700		N.A.	1,700	MMp476	
Subtotal				39,488		2,313	41,801		
Contingency			10%	3,949	10%	231	4,180	MEp6	MEp6
Total Construction Cost				**43,437**		**2,544**	**$45,981**		
Design Fee				N.A.	6.0%	2,759	2,759		
SIOH				N.A.	6.0%	2,759	2,759		
Total Project Cost				**43,437**		**8,062**	**$51,499**		

LEGEND:

Note (1)	1994 Means Mechanical Cost Data, page ###, escalated by 1.03 per year.
MEp###	1996 Means Electrical Cost Data, page ###.
MMp###	1996 Means Mechanical Cost Data, page ###.
Vendor	Quote from equipment manufacturer, used list price x 0.75 for contractors price.

CONSTRUCTION COST ESTIMATE

Project:	Individual Dedicated Compressors	RS&H No.:	694-1331-004
Location:	Pine Bluff Arsenal, AR	Date:	6/25/96
Basis:	Schematic Design	Estimator:	W. Todd
ECO Number:	C3 A	Filename:	EST-C3-2.XLS

ITEM DESCRIPTION	QUANTITY No.	QUANTITY Unit	MATERIAL/EQUIP $/Unit	MATERIAL/EQUIP Total	LABOR $/Unit	LABOR Total	TOTAL COST	SOURCE Material	SOURCE Labor
Compressor, 200cfm, 100psi, water cool, 50hp motor, v-belt drive, aftercooler, separator, S-S controls, inlet filter, gages & base.	1	Ea	27135	27,135	1114	1,114	28,249	Vendor	MMp248(1)
Dryer and Filter, 200cfm	1	Ea	6675	6,675	112	112	6,787	MMp290	MMp290
Electric motor installation, 460 V, 3 phase, 50 hp, safety switches, starter, wire, conduit & couplings.	1	Ea	1525	1,525	1200	1,200	2,725	MEp321	MEp321
Water piping, 1", Sched. 40, threaded, w/hangers	50	LF	2.5	125	4.54	227	352	MMp139	MMp139
Air piping, 2", Schedule 40 welded joints, w/ hangers	50	LF	5.68	284	7.1	355	639	MMp139	MMp139
Concrete Slab, 6" x 8' x 8'	1.19	CY	62.37	74	21	25	99	MMp46	MMp46
Storage Shed, 8' x 8'	64	SF	75	4,800	1.52	97	4,897	MMp11	MMp11
Subtotal Bare Costs				40,618		3,130	43,748		
Retrofit Cost Factors			0%	0	0%	0	0	MMp6	MMp6
Subtotal				40,618		3,130	43,748		
City Cost Index			0.952	(1,950)	0.632	(1,152)	(3,102)	MMp533	MMp533
Subtotal				38,668		1,978	40,646		
OH & Profit Markups			10%	3,867	53%	1,048	4,915	MMp7	MMp475
Subtotal				42,535		3,026	45,561		
State Sales Taxes			4.5%	1,914		N.A.	1,914	MMp476	
Subtotal				44,449		3,026	47,475		
Contingency			10%	4,445	10%	303	4,748	MEp6	MEp6
Total Construction Cost				**48,894**		**3,329**	**$52,223**		
Design Fee				N.A.	6.0%	3,133	3,133		
SIOH				N.A.	6.0%	3,133	3,133		
Total Project Cost				**48,894**		**9,595**	**$58,489**		

LEGEND:

Note (1)	1994 Means Mechanical Cost Data, page ###, escalated by 1.03 per year.
MEp###	1996 Means Electrical Cost Data, page ###.
MMp###	1996 Means Mechanical Cost Data, page ###.
Vendor	Quote from equipment manufacturer, used list price x 0.75 for contractors price.

CONSTRUCTION COST ESTIMATE

Project:	Individual Dedicated Compressors	RS&H No.:	694-1331-004
Location:	Pine Bluff Arsenal, AR	Date:	6/25/96
Basis:	Schematic Design	Estimator:	W. Todd
ECO Number:	C3A	Filename:	EST-C3-6.XLS

ITEM DESCRIPTION	QUANTITY		MATERIAL/EQUIP		LABOR		TOTAL COST	SOURCE	
	No.	Unit	$/Unit	Total	$/Unit	Total		Material	Labor
Compressor, 600cfm, 120psi, water cool, 150hp motor, v-belt drive, aftercooler, separator, S-S controls, inlet filter, gages & base.	1	Ea	59220	59,220	3283	3,283	62,503	Vendor	MMp248(1)
Dryer and Filter, 600cfm	1	Ea	10350	10,350	190	190	10,540	MMp290	MMp290
Electric motor installation, 460 V, 3 phase, 150 hp, safety switches, starter, wire, conduit & couplings.	1	Ea	6250	6,250	2175	2,175	8,425	MEp321	MEp321
Water piping, 2", Sched. 40, threaded, w/hangers	50	LF	4.49	225	6.75	338	563	MMp139	MMp139
Air piping, 4", Schedule 40 welded joints, w/ hangers	50	LF	12.02	601	11.7	585	1,186	MMp140	MMp140
Concrete Slab, 6" x 10' x 10'	1.85	CY	62.37	116	21	39	155	MMp46	MMp46
Storage Shed, 10' x 10'	100	SF	75	7,500	1.52	152	7,652	MMp11	MMp11
Subtotal Bare Costs				84,262		6,762	91,024		
Retrofit Cost Factors			0%	0	0%	0	0	MMp6	MMp6
Subtotal				84,262		6,762	91,024		
City Cost Index			0.952	(4,045)	0.632	(2,488)	(6,533)	MMp533	MMp533
Subtotal				80,217		4,274	84,491		
OH & Profit Markups			10%	8,022	53%	2,265	10,287	MMp7	MMp475
Subtotal				88,239		6,539	94,778		
State Sales Taxes			4.5%	3,971		N.A.	3,971	MMp476	
Subtotal				92,210		6,539	98,749		
Contingency			10%	9,221	10%	654	9,875	MEp6	MEp6
Total Construction Cost				**101,431**		**7,193**	**$108,624**		
Design Fee				N.A.	6.0%	6,517	6,517		
SIOH				N.A.	6.0%	6,517	6,517		
Total Project Cost				**101,431**		**20,227**	**$121,658**		

LEGEND:

Note (1)	1994 Means Mechanical Cost Data, page ###, escalated by 1.03 per year.
MEp###	1996 Means Electrical Cost Data, page ###.
MMp###	1996 Means Mechanical Cost Data, page ###.
Vendor	Quote from equipment manufacturer, used list price x 0.75 for contractors price.

RS&H

SUBJECT PBA ELEC & HTG STUDY
REPLACE AIR PIPING
DESIGNER W. TODD
CHECKER

AEP NO 694 1331 004
SHEET ____ OF ____
DATE 7-1-96
DATE

ECO - C3 - B   Replace Compressed Air (CA) Piping

Since a detailed study of the CA piping was not in the Scope of Work, this analysis makes the following assumptions:

1) The CA pipe is 30% 4" and 70% 2" diameter.

2) The compressed air distribution system is the same length as the steam distribution system.

3) The new CA piping will utilize the existing supports and hangers.

4) The savings is based on reduced compressor operating time, See attached Calculations.

Savings = 5847.3 MBtu /YR

5) There is currently little or no maintenance on the existing system, so no O&M savings were considered for this ECO.

ECO CALCULATIONS

Project:	Replace Compressed Air Piping	RSH No.:	694-1331-004
Location:	Pine Bluff Arsenal, AR	Date:	7/2/96
ECO No.:	C3-B	Designer:	W. Todd

Assumptions:

1. Number compressors operating at full load during production:		5		(estimated by operating staff)
2. Number compressors operating at half load during production:		0		(estimated by operating staff)
3. Number compressors operating at full load during non-production:		2		(estimated by operating staff)
4. Number compressors operating at half load during non-production:		1		(estimated by operating staff)
5. Exist. compressors:	Design CA supply capacity:	825	cfm	(from nameplate data)
	Calculated electric demand:	145.9	kW	(from nameplate data)
	Measured electric demand:	130.7	kW	(measured during survey)
	Actual percent motor load:	0.90		(measured kW / nameplate kW)
	Demand per design supply cfm:	0.158	kW/cfm	(measured kW / design cfm)
6. New Compressors:	Design CA supply capacity:	825	cfm	(from nameplate data)
	Electric demand at full load:	145.9	kW	(from nameplate data)
	Estimated percent motor load:	0.90		(measured kW / nameplate kW)
	Estimated electric demand:	130.7	kW	(measured during survey)
	Demand per design supply cfm:	0.158	kW/cfm	(measured kW / design cfm)
7. Production schedule: 10 hr/day, 4 day/wk, 52 wks/yr				
8. Compressed air distribution:	Process buildings (production) =	60%		(Assume 3.0 comp. / 5 comp)
	Process buildings (non-prod) =	10%		(Assume 0.5 comp. / 5 comp)
	Leaks at or in buildings =	10%		(Assume 0.5 comp. / 5 comp)
	Leaks in main CA dist. piping =	30%		(Assume 1.5 comp. / 5 comp)
9. Average cost of electric energy consumed at PBA :		$16.79	/MBtu	(calculated from electric bills)

Estimate of compressed air supplied by the main system:

During Production =	5	comp. x	825	cfm/co. +	0	comp. x	412.5	cfm/co. =	4125 cfm
During Non-prod. =	2	comp. x	825	cfm/co. +	1	comp. x	412.5	cfm/co. =	2063 cfm

Estimate of current energy consumption:

During Production =	0.158 kW/cfm x	4125 cfm	=	651.8 kW
	651.8 kW x	2080	hrs/year =	1355744 kWh/yr
	1355744 kWh/yr x	0.003413	MB/kWh=	4627.2 MBtu/yr
During Non-prod. =	0.158 kW/cfm x	2063 cfm	=	326.0 kW
	326.0 kW x	6680	hrs/year =	2177680 kWh/yr
	2177680 kWh/yr x	0.003413	MB/kWh=	7432.4 MBtu/yr
Total =	4627.2 MBtu/yr +	7432.4	MBtu/yr =	12059.6 MBtu/yr

ECO - C3 - B

Estimate of compressed air required at the buildings:

During Production =	4125 cfm	x	60%	+	4125 cfm	x	=	10%	=	2888 cfm
During Non-prod. =	4125 cfm	x	10%	+	4125 cfm	x		10%	=	825 cfm

Estimate of energy consumption after ECO implementation:

During Production =	0.158 kW/cfm	x	2888 cfm	=	456.3 kW
	456.3 kW	x	2080 hrs/year	=	949104 kWh/yr
	949104 kWh/yr	x	0.003413 MB/kWh	=	3239.3 MBtu/yr
During Non-prod. =	0.158 kW/cfm	x	825 cfm	=	130.4 kW
	130.4 kW	x	6680 hrs/year	=	871072 kWh/yr
	871072 kWh/yr	x	0.003413 MB/kWh	=	2973 MBtu/yr
Total =	3239.3 MBtu/yr	+	2973 MBtu/yr	=	6212.3 MBtu/yr

Estimate of annual energy and cost savings:

Energy Savings =	12059.6 MBtu/yr	-	6212.3 MBtu/yr	=	5847.3 MBtu/yr
Cost Savings =	5847.3 MBtu/yr	x	$16.79 /MBtu	=	$98,176 /Year

CONSTRUCTION COST ESTIMATE

Project:	Replace Compressed Air Distribution Piping	RS&H No.:	694-1331-004
Location:	Pine Bluff Arsenal, AR	Date:	7/2/96
Basis:	Schematic Design	Estimator:	W. Todd
ECO Number:	C3-B	Filename:	EST-C3B.XLS

ITEM DESCRIPTION	QUANTITY		MATERIAL/EQUIP		LABOR		TOTAL COST	SOURCE	
	No.	Unit	$/Unit	Total	$/Unit	Total		Material	Labor
Pipe, 4" sch 40, galv., thread	12672	LF	18.1	229,363	12	152,064	381,427	MMp139 (1)	MMp139(1)
Pipe, 2" sch 40, galv., thread	29568	LF	6.8	201,062	6.75	199,584	400,646	MMp139 (1)	MMp139(1)
Pipe fittings, 4" (0.05 x 4" LF)	634	Ea	87	55,123	72	45,619	100,742	MMp147	MMp147
Pipe fittings, 2" (0.05 x 2" LF)	1478	Ea	17.75	26,242	24	35,482	61,724	MMp146	MMp146
Valves, 4", flanged, 125 lb	10	Ea	415	4,150	144	1,440	5,590	MMp191	MMp191
Valves, 2", thread, class 150	40	Ea	59.5	2,380	22	880	3,260	MMp188	MMp188
Remove existing piping, 2"	42240	LF		0	1.2	50,688	50,688	MMp22	MMp22
Personnal hoist rental	12	Mo.	1450	17,400		0	17,400	MMp15	
Subtotal Bare Costs				535,720		485,757	1,021,477		
Retrofit Cost Factors			5%	26,786	9%	43,718	70,504	MMp6	MMp6
Subtotal				562,506		529,475	1,091,981		
City Cost Index			0.952	(27,000)	0.632	(194,847)	(221,847)	MMp533	MMp533
Subtotal				535,506		334,628	870,134		
OH & Profit Markups			10%	53,551	53%	177,353	230,904	MMp7	MMp475
Subtotal				589,057		511,981	1,101,038		
State Sales Taxes			4.5%	26,508		N.A.	26,508	MMp476	
Subtotal				615,565		511,981	1,127,546		
Contingency			10%	61,557	10%	51,198	112,755	MEp6	MEp6
Total Construction Cost				**677,122**		**563,179**	**$1,240,301**		
Design Fee				N.A.	6.0%	74,418	74,418		
SIOH				N.A.	6.0%	74,418	74,418		
Total Project Cost				**677,122**		**712,015**	**$1,389,137**		

LEGEND:

- Note (1) Assumes the compressed air piping is the same length as the steam piping.
- MEp### 1996 Means Electrical Cost Data, page ###.
- MMp### 1996 Means Mechanical Cost Data, page ###.

RS&H

SUBJECT PBA ELEC & HTG STUDY
COMPRESSED AIR PIPING
DESIGNER W. TODD
CHECKER

AEP NO 694-1331-004
SHEET ______ OF ______
DATE 7-1-96
DATE

ECO - C3 - C REPAIR COMPRESSED AIR PIPING

To be conservative it is assumed that all of the leaks are equivalent to about 1/16" diameter. From Compressed Air Systems, the leakage rate at 100 psig is about 4 cfm.

$$\text{Total estimated leaks} = \frac{1237 \text{ cfm}}{4 \text{ cfm/leak}} = 309 \Rightarrow 300 \text{ leaks}$$

We did not observe this many leaks but feel this is a very conservative method of estimating the cost of repair.

Assume the leaks are distributed as follows:

100 valves, Remove and replace

100 fittings, remove and replace

100 pipe sections, remove and replace.

The energy savings are the same as that estimated for ECO - C3 - B:

Savings = 5847.3 MBtu /YR

CONSTRUCTION COST ESTIMATE

Project: Repair Compressed Air Distribution Piping
Location: Pine Bluff Arsenal, AR
Basis: Schematic Design
ECO Number: C3-C

RS&H No.: 694-1331-004
Date: 7/1/96
Estimator: W. Todd
Filename: EST-C3C.XLS

ITEM DESCRIPTION	QUANTITY No.	QUANTITY Unit	MATERIAL/EQUIP $/Unit	MATERIAL/EQUIP Total	LABOR $/Unit	LABOR Total	TOTAL COST	SOURCE Material	SOURCE Labor
Rental Leak Detector	1	Mo.	200	200		0	200	Vendor	
Survey CA piping for leaks	20	Day		0	600	12,000	12,000		Est. (1)
Replace Leaking Valves									
Remove existing valve	100			0	48	4,800	4,800		MMp191
Install new valve, 2", gate	100		252	25,200	48	4,800	30,000	MMp191	MMp191
Repair Leaking Piping									
Cut existing pipe section	100	Ea		0	15.15	1,515	1,515		Est. (2)
Pipe, 2", sch 40 steel	100	LF	4.82	482		0	482	MMp139	
Joint weld - equip & labor	200	Ea	3.29	658	27	5,400	6,058	MMp144	MMp144
Repair Leaking Fittings									
Cut existing fitting	100	Ea		0	15.15	1,515	1,515		Est. (2)
90 deg elbow, steel	100	LF	6.65	665		0	665	MMp158	
Joint weld - equip & labor	200	Ea	3.29	658	27	5,400	6,058	MMp144	MMp144
Personnal Hoist Rental	2	Mo.	1450	2,900		0	2,900	MMp15	
Subtotal Bare Costs				30,763		35,430	66,193		
Retrofit Cost Factors			0%	0	0%	0	0	MMp6	MMp6
Subtotal				30,763		35,430	66,193		
City Cost Index			0.952	(1,477)	0.632	(13,038)	(14,515)	MMp533	MMp533
Subtotal				29,286		22,392	51,678		
OH & Profit Markups			10%	2,929	53%	11,868	14,797	MMp7	MMp475
Subtotal				32,215		34,260	66,475		
State Sales Taxes			4.5%	1,450		N.A.	1,450	MMp476	
Subtotal				33,665		34,260	67,925		
Contingency			10%	3,367	10%	3,426	6,793	MEp6	MEp6
Total Construction Cost				**37,032**		**37,686**	**$74,718**		
Design Fee				N.A.	6.0%	4,483	4,483		
SIOH				N.A.	6.0%	4,483	4,483		
Total Project Cost				**37,032**		**46,652**	**$83,684**		

LEGEND:

- Note (1) Assumes 20 man-days to survey the comp air piping system. $550 /day + travel
- Note (2) Assumes 15 minutes per cut x 2 cuts at $30.30 per hour (MMp475).
- MEp### 1996 Means Electrical Cost Data, page ###.
- MMp### 1996 Means Mechanical Cost Data, page ###.
- Vendor Quote from GE Rents, see attached information.

ECO-C3-A

RS&H
Reynolds, Smith and Hills, Inc.
Architectural, Engineering, Planning and Environmental Services

Telephone Call Confirmation

Date: June 24, 1996

Project Number: 694-1331-004

Project Name: PBA Electric and Heating Study

Received: **Placed:** by W. Todd

Local: **Long Dist.:** 800-682-9868

Conversed with: Arnold Gerst

of Gardner Denver Machinery, Inc., Quincy, IL

Regarding: New Dedicated Compressors for PBA

We discussed which type of compressor should be used for PBA. The existing surplus Gardner Denver compressors are MCY series, two stage, water cooled reciprocating type. Screw compressors are lower in first cost than the reciprocating type, however, their operating costs are higher and they are not as durable as reciprocating compressors. We decided to go with water cooled reciprocating compressors. Arnold will fax me a quote (by Wednesday 6/24/96) for the following water cooled, oil free, 120 psig, compressor packages:

100 cfm

200 cfm

600 cfm.

The compressor packages include the bare compressor, v-belt drive, electric motor, solid state programmable controller, temperature gages and regulator, aftercooler, separator, and inlet air filter/silencer all mounted on a structural steel base. A dryer is not included. The base would have to be extended to add this on to the package.

Distribution: C. Warren
File

By William T. Todd, PE

A.5.C3-19

ECO-C3-A

Gardner Denver

Date: 25 June 96

To: Reynolds, Smith & Hills

Attn: Bill Todd

Fax No: 904-279-2489

No. of Pages: 1

Gardner Denver Machinery Inc.
1800 Gardner Expressway
Quincy, IL 62301
Phone: (217) 221-8728, Ext. 728
Fax: (217) 224-7814

FROM: ARNOLD GERST

REFERENCE: Compressor Package – Oilfree 120 PSIG

A. 100 ICFM → MBVED, 8"x5", Non lub package
List Price $34,205.00 each

B. 200 ICFM → MBVEG, 10½"x5", Non lub pkg.
List Price $36,180.00 each

C. 600 ICFM → MCYML, 15½+8½x5, Non lub pkg
List Price $78,960.00 each

All prices are F.O.B. Quincy IL.

MBV series are single stage, single vertical cylinder, water Cooled Compressor pkgs.

MCY series is a two stage, Y cylinder, water Cooled Compressor pkg.

Arnold Gerst

A.5.C3-20

ECO-C3-A

CUSTOMER JOHN BROWN / ARMY SHEET 1 OF 4 REV ____ DATE ____ M.RS

CUSTOMER P.O.# PB-0303-0056 MAT'L. REQ'D. BY 6/16/89 REV ____ DATE ____ CERT. OF C

B/M FOR 1 UNITS 2 REQ'D. NBR. LIT. REQ'D. 38 REV ____ DATE ____ ☐ CERT. OF T

ITEM-CODE	QUAN.	DESCRIPTION	SP	REV	P.O. NBR	SUPPLIER	REC.	PART NBR.
1-2	1	GARDNER DENVER MODEL MCYMH →			MCYM-H			
		14¾" x 8½ x 5" NON LUBE AIR						
		COMPRESSOR W/INTERCOOLER &						
		SHEAVE						
2-2	1	SIEMENS MOTOR 150HP, 1800RPM						
		460/3/60 1.15 SF HIGH EFF.						
		TEFC 445T FRAME						
3-2	1	SLIDE BASE FOR 445-T FRAME						
		MOTOR WITH 2 TENSIONING BOLTS						
4-2	1	BASCO MODEL 05084 AFTERCOOLER						
		TEMA C' DESIGN - ASME						
5-2	1	SOLBERG (OR EQUAL) MODEL						
		FS-274P-600 W/6" FLANGE						
		CONN. AND PAPER ELEMENT						
		AND WEATHER HOOD						
6-2	1	DAYTON FLEX HOSE STOCK NO.						
		4Z490 3" 150# FLANGE CONN.						

A.5.C3-21

AIR COMPRESSOR DATA

Survey by: GWF / WTT Date: 3/27/96
Maintenance Name: Phone:
Building Number: 34-140 Compressor I.D. No.: 4
Service area or Loads: Area 3 Section 4 and Sections 1, 2 and 3 via header piping system.

Compressor Specifications:
Mfg. & Model #: INGERSOLL-RAND, TYPE XLE, MODEL 16-10x7
Type: Recip.: ✓ Cent.: ___ Other: Date ≈ 1967 SN: JH4868
Capacity (cfm): 825 Operating Pressure (psig): 130

Electric Motor:
Type: Synchronous ✓ Induction: ___ Other:
Volts: 460 Amps: 206 Phases: 3 Hz: 60 RPM: 600
HP: 173 Mfg: GE Model No.: 5SR684A60

Operation Schedule: hr/da: 24 da/wk: 7 mn/yr: 12
Cooling Method: Air: ___ Water: ✓
Air Source Location: Outdoors: ✓ Other:
Control System: Pneumatic staging control - 2 stages
Manual on/off control.

Maintenance Schedule: as required, no PM

O&M log available: Yes No Copies Obtained: Yes No

Auxiliary Equipment: (Air Dryer, Heat Recovery, etc.)
Air dryer disconnected.

Heat Recovery Potential: (Accessibility, heat load nearby) Use cooling water to preheat boiler feed water? ~ 25° ΔT

General Condition/Comments/Problems:
PANEL { AC Amps = 169
DC AMPS = 34.5

ELECTRIC MOTOR DATA SHEET

Survey Date: 3/27 & 1/30/96; Survey By: WTT / CSW

Equipment ID/Function: Compressor No. 4

Location: Bldg. 34 140

Nameplate Data:

Manufacturer: General Electric

Model No.: 5SR 684 A60; Serial No.: DE 837 1527

Insulation Class: ____; NEMA Design: ____; Code: A; Efficiency: ____

Horsepower 173; Frame 965Y; RPM 600; Service Factor ____

Volts 460; Amps 206; Phases 3; Hz 60; PF 0.8; kW ____

Type: Synchronous ✓; Induction ____; Other TYPE TS

For Synchronous Motors: DC Excitation Volts 125; Amps 33

Electrical Measurements: ← CSW → | ← WTT →

Measurements	Phase 1	Phase 2	Phase 3	Phase	Phase 1-2	Phase 2-3
Volts(rms)	478.6	4.15	483.1		511.1	502.6
Amps(rms)	176.6	191.0	195.1		168.8	185.5
kW	86.12	-0.38	51.58		89.95	36.61
kVAR	1.77 LE	0.65 LA	80.07 LE		2.73 LE	80.29 LE
kVA	86.16	0.76	95.27		90.02	88.27
Power Factor	0.99	-0.5	0.54		0.99	0.41
dPF	0.99	-0.5	0.54		0.99	0.41
kdVA	2.010	44.43	1.995		2.092	2.103

General Condition/Comments: Motor Control Panel Readings:
169 Amps AC ; 34.5 Amps DC

Compressed Air Systems by E.M. TALBOTT

strainers should perform well for many years; however, they require periodic inspection and service.

4.3.5 Filter/Lubricators

The filter, regulator and lubricator are used to cleanse the air at the point of use, to regulate the pressure and thus the power or thrust of the tool or other pneumatic equipment, and finally, to lubricate that equipment, in that order. If the tool or other pneumatic equipment is not protected (by a filter) from serious contaminants, or if the equipment is not properly lubricated,it may wear more rapidly and thus may reduce efficiency and expend more air to accomplish the same job.

A clogged filter will have the effect of added pressure drop and a resulting loss of energy as explained previously. Only regular inspection and attention can keep these items in proper order.

The in-line lubricator is available in several designs. Different air users may require different types of lubricators.Manufacturers' tests have indicated that proper lubrication of air tools results in reduced air consumption for governed tools(up to 50% compared to dry tools) and increased speeds for ungoverned tools.

4.3.6 System Leakage

Of all of the maintenance failures, system leakage probably results in more lost compressed air energy than any other single factor. Plants have been observed where leakage losses are a modest 10% of the total compressed air capacity. Although this is "modest" by leakage standards, it is a significant annual dollar cost. Other plants have been observed with leakage rates in the range of 20% to 40% of total air usage. The cost of this leakage is high and avoidable.

The table below shows a conservative estimate of the annual cost of leaks of various sizes:

Equivalent Hole Diameter	Leakage Rate scfm	10^3 scf per year (4000 hrs)	Cost per year,$ (@25¢/1000 cf)
1/64"	0.25	60	15
1/32"	0.99	238	59
1/16"	3.96	950	238
1/8 "	15.86	3806	952
1/4 "	63.44	15226	3806
3/8 "	142.74	34258	8564

Air at 100 psig
Orifice with sharp edges (Coefficient of flow = 0.61. Leakage and cost could be increased 60 percent for well rounded hole - coefficient = 0.97).

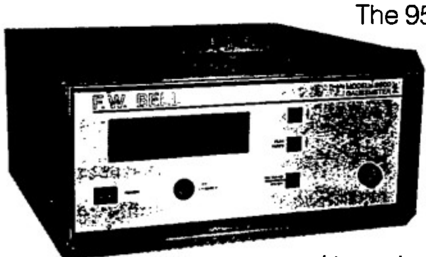
ECO-C3-C

Gaussmeters

F.W. Bell

F.W. Bell 9200 Digital Gaussmeter
Microprocessor-based gaussmeter measures either ac or dc magnetic fields. 3.5-digit display has peak hold function and reads in either gauss or telsa. Six measurement ranges from 20 G to 20 kG. DC accuracy: ±0.5%. Frequency response: dc to 5 kHz. Analog output of 2 volts full scale for recording. Built-in zero chamber. Autoranging. Includes axial and transverse probes. Rechargeable battery. Net weight: 8 lb.

F.W. Bell 9500 Digital Gaussmeter



The 9500 is a microprocessor-based, menu-driven gaussmeter with eight measurement ranges from 3 G to 30 kG. 3.75-digit LCD display with analog bar-graph and peak hold. Measurement results can be displayed in either gauss or telsa. DC accuracy: ±0.25%. Frequency response: dc to 5 kHz. Analog output: 3 volts full scale. Includes axial and transverse probes. Net weight: 19 lb.

Holaday

Holaday HI-3604 ELF/Power Frequency Survey Meter
Measures electric and magnetic fields associated with 50/60 Hz power lines and electrically operated equipment. Frequency range: 30 to 1000 Hz. Magnetic field: 0.1 mG to 20 G in five ranges. Electrical field: 1 V/m (volt per meter) to 200 kV/m in five ranges. Features LCD display, bar-graph analog indicator for quickly locating maximum field strength and "hot spots", full autoranging, sealed membrane switch control panel, and data logging capability which allows saving up to 127 readings in internal memory. Net weight: 5 lb.

Leak Detectors

Biddle

Keith at X-7015
Rent for $200 / month

Biddle 569001 Leak and Corona Detector
Ultrasonic leak and corona detector for use with electrical corona sources and gas leaks. Visual and audible outputs indicate presence of ultrasonic signals from poor connections, faulty equipment or RF signal sources. Unit can detect a 0.002 in. leak at 5 ft. with only 10 psi of pressure. Frequency range: 35 to 45 kHz. Battery powered. Net weight: 6 lb.

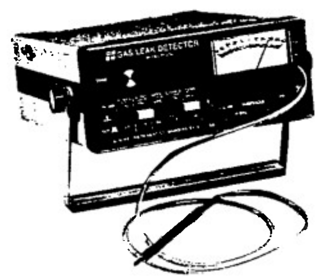
General Electric

General Electric H25 Ferret Halogen Leak Detector
Measures leaks down to 0.0005 oz/yr. Senses presence of halogen gas. Manual or automatic zero to background level. Complete with probe. Net weight: 17 lb.

General Electric LS-20 Halogen Leak Standard
Standard used for calibrating halogen leak detectors. Must specify leak rate desired: 0 to 0.005/0.05/0.5/5.0/15.0 oz/yr. Net weight: 4 lb.

Gow-Mac

Gow-Mac 21-250 Gas Leak Detector
Gas leak detector for helium, argon, carbon dioxide and



refrigerants. Audible tone varies proportionally with meter deflection. Sensitivity: 1 x 10^{-5} cc/s (helium). Operates on 115 V/230 V, 50/60 Hz or internal rechargeable batteries. Net weight: 9 lb.

If You Have A Particular Need, But Don't See The Equipment Listed Here, Call 1-800-GE-RENTS.

A.5. C3-25

EXHIBIT G
COMPRESSED AIR DEMAND FOR MOBILIZATION CONDITION

COMPRESSED AIR

EQUIPMENT EFFECTIVNESS FACTOR %

PINE BLUFF ARSENAL, ARKANSAS
DEPARTMENT OF THE ARMY

BUILDING NUMBER	BLDG USE	CURRENT DEMAND COMPRESSED AIR PROCESS LOAD CFM	PRESSURE	PARTIAL BASELINE EMERGENCY PROCESS LOAD CFM	PRESSURE	BASELINE EMERGENCY PROCESS LOAD CFM	PRESSURE
31080	ELECTRONIC CALIBRATION FACILITY						
31100	MAINT FACILITY						
31150	PRODUCTION OFFICE						
31310	RAW MAT. WAREHOUSE						
31330	RAW MAT. WAREHOUSE						
31420	RAW MAT. WAREHOUSE						
31440	RAW MAT. WAREHOUSE						
31520	MIX BUILDING						
31530	FILL AND PRESS	200	120	200	120	200	120
31531	OFFICE AND RESTROOMS						
31540	DOWNLOAD FACILITY						
31570	MUNITIONS STORAGE						
31620	PYRO MIX BLDG (THERMATE MIX)	200	120	200	120	200	120
31630	FILL AND PRESS	1800	120	0	0	3000	120
31631	BREAK AND RESTROOMS						
31640	ASSEMBLY	10	110	10	110	10	110
31670	STORAGE						
31720	PYROTECHNIC PRODUCTION	10	120	10	120	10	10
31730	STORAGE						
31820	STORAGE						
31830	AMMO QUAL FAC						
31860	STORAGE						
		2220		420		3420	
32000	CAFETERIA						
32030	INSPECTION GARAGE						
32035	ORDINANCE SHOP						
32070	IMPREG AND LAUNDRY	10	120	10	120	10	120
32080	MHE BATTERY SHOP						
32090	WAREHOUSE						
32100	ELECTRONIC CALIBRATION FACILITY						
32130	AMMO QUAL FAC						
32150	AMMO QUAL FAC						
32230	FILTER BLDG	400	120	400	120	400	120
32270	WAREHOUSE	1800	120	1800	120	1800	120

A.5.C3-26

ECO-C3

ECO-C3

EXHIBIT G
COMPRESSED AIR DEMAND FOR MOBILIZATION CONDITION

COMPRESSED AIR

EQUIPMENT EFFECTIVNESS FACTOR %

PINE BLUFF ARSENAL, ARKANSAS
DEPARTMENT OF THE ARMY

BUILDING NUMBER	BLDG USE	CURRENT DEMAND COMPRESSED AIR PROCESS LOAD CFM	PRESSURE	PARTIAL BASELINE EMERGENCY PROCESS LOAD CFM	PRESSURE	BASELINE EMERGENCY PROCESS LOAD CFM	PRESSURE
32310	RAW MAT. WAREHOUSE						
32330	RAW MAT. WAREHOUSE						
32420	RAW MAT. WAREHOUSE						
32440	EQUIPEMENT WAREHOUSE						
32510	PROD ENGR LAB						
32520	PROD ENGR LAB						
32530	FORMER BZ FACILITY						
32531							
32540	FORMER BZ FACILITY						
32550	AMMO QUAL FAC						
32570	OPERATIONS GENERAL PURPOSE						
32610	DRYING	100	120	100	120	100	120
32620	COLORED SMOKE MIX (GLATT)	178	120	356	120	356	120
32630	STORAGE						
32631	OFFICE AND RESTROOMS						
32640	PYROTECHNIC PRODUCTION	1200	120	0	0	1200	120
32670	SUU-7 TEST						
32720	PROD ENGR LAB						
32730	PROD ENGR LAB						
32820	MATERIAL STORAGE						
32830	MATERIAL STORAGE						
32860	STORAGE						
		3688		2666		3866	
33080	SAFETY EQUIP						
33100	CHANGE HOUSE						
33150	PRODUCTION						
33310	RAW MAT. WAREHOUSE						
33330	RAW MAT. WAREHOUSE						
33420	RAW MAT. WAREHOUSE						
33440	RAW MAT. WAREHOUSE						
33520	MIX BUILDING						
33530	FILL AND PRESS	2100	120	2100	120	2100	120
33531	PUBLIC TOILET						
33540	STORAGE						
33550	IN PROCESS STORAGE						

A.5.C3-27

ECO-C3

EXHIBIT G
COMPRESSED AIR DEMAND FOR MOBILIZATION CONDITION

EQUIPMENT EFFECTIVNESS FACTOR %

PINE BLUFF ARSENAL, ARKANSAS
DEPARTMENT OF THE ARMY

COMPRESSED AIR

BUILDING NUMBER	BLDG USE	CURRENT DEMAND COMPRESSED AIR PROCESS LOAD CFM	PRESSURE	PARTIAL BASELINE EMERGENCY PROCESS LOAD CFM	PRESSURE	BASELINE EMERGENCY PROCESS LOAD CFM	PRESSURE
33570	LAP	0	0	0	0	0	0
33620	STARTER MIX BUILDING	10	120	10	120	10	120
33630	FILL AND PRESS	0	0	1800	120	1800	120
33631	OFFICE AND RESTROOMS						
33640	ASSEMBLY BUILDING						
33650	IN PROCESS STORAGE						
33670	M116 LAP	600	120	600	120	600	120
33720	KC103 PROP						
33730	QC TEST FAC						
33820	STARTER MIX SLUGS						
33830	COMPONENT STORAGE						
33860	STORAGE IGLOO						
		2710		4510		4510	
34110	WP FILLING	600	120	600	120	600	120
34120	AMMO QUAL FAC						
34130	WP UNLOAD TANKS						
34170	WP BULK STORAGE						
34350	ASSEMBLY AND PACKOUT						
34370							
34420							
34430	RAW MATERIAL WAREHOUSE						
34620							
34630	PYROTECHNIC PRODUCTION	120	130	120	130	120	130
34640	HC MIX	100	120	100	120	100	120
34650	START MIX SLEEVE						
34660	SUB ASSEMBLY						
34820	STORAGE						
34910	FE MAINTENANCE SHOP						
34970	ADMIN BUILDING						
		820		820		820	
42960	GRENADE TEST BUILDING						
44110	LAP	600	120	600	120	600	120

A.5.C3-28

ECO-C3

PBA Compressor Operating Hours									6/17/96
		32060		33060		34140		Total	Total
		No. 1	No. 2	No. 1	No. 2	No. 1	No. 2	Comp.	Comp.
Day	Date	Op Hrs	Op Hrs	Op Hrs	Op Hrs	Op Hrs	Op Hrs	Op Hrs	% Hrs
Tuesday	1/16/96	20.00	0.00	24.00	0.00	0.00	10.00	54.00	38%
Wednesday	1/17/96	19.25	0.00	24.00	13.50	0.00	9.00	65.75	46%
Thursday	1/18/96	24.00	0.00	24.00	23.00	0.00	17.00	88.00	61%
Friday	1/19/96	24.00	0.00	24.00	0.00	0.00	24.00	72.00	50%
Saturday	1/20/96	24.00	0.00	24.00	0.00	0.00	24.00	72.00	50%
Sunday	1/21/96	24.00	0.00	24.00	0.00	0.00	24.00	72.00	50%
Monday	1/22/96	21.00	0.00	24.00	0.00	0.00	24.00	69.00	48%
Total Oper. Hours		156.25	0.00	168.00	36.50	0.00	132.00	492.75	
Total Available Hours		168	168	168	168	168	168	1008	
Percent Oper. Hours		93%	0%	100%	22%	0%	79%	49%	

A.6 ENERGY CONSUMPTION AND COST DATA

Pine Bluff Arsenal - Electrical Demand and Heating Study
Annual Energy Use Data
Filename: ENUSE-95.XLS

	Natural Gas			Total Electricity		Electric Energy Substations A & B					Electric Demand			Overall Electricity		
Mon-Yr	MBtu	Cost,$	$/MBtu	kWh	MBtu	kWh	MBtu	Cost,$	$/kWh	$/MBtu	kW	Cost, $	$/kW	Total $	$/kWh	$/MBtu
Feb-95	65,166	$169,839	$2.61	2,058,000	7,024	1,483,020	5,062	$39,370	$0.027	$7.78	2,385	$29,979	12.57	$69,349	$0.047	$13.70
Mar-95	58,220	$160,030	$2.75	1,946,000	6,642	1,405,404	4,797	$35,972	$0.026	$7.50	2,449	$30,783	12.57	$66,755	$0.047	$13.92
Apr-95	44,683	$135,613	$3.03	2,189,600	7,473	1,602,216	5,468	$41,084	$0.026	$7.51	2,249	$33,923	15.08	$75,007	$0.047	$13.72
May-95	37,697	$111,964	$2.97	1,517,600	5,180	1,069,992	3,652	$34,997	$0.033	$9.58	2,696	$27,818	10.32	$62,814	$0.059	$17.20
Jun-95	38,392	$113,603	$2.96	2,240,000	7,645	1,552,320	5,298	$54,138	$0.035	$10.22	2,730	$37,829	13.86	$91,967	$0.059	$17.36
Jul-95	37,838	$110,372	$2.92	2,651,600	9,050	1,804,572	6,159	$64,411	$0.036	$10.46	4,104	$57,162	13.93	$121,572	$0.067	$19.74
Aug-95	34,199	$102,086	$2.99	2,769,200	9,451	1,876,644	6,405	$63,548	$0.034	$9.92	4,236	$59,019	13.93	$122,568	$0.065	$19.14
Sep-95	35,284	$104,505	$2.96	2,699,200	9,212	1,907,136	6,509	$50,930	$0.027	$7.82	5,156	$64,809	12.57	$115,740	$0.061	$17.78
Oct-95	41,937	$119,834	$2.86	1,792,000	6,116	1,252,944	4,276	$33,727	$0.027	$7.89	3,396	$42,687	12.57	$76,414	$0.061	$17.87
Nov-95	58,597	$158,956	$2.71	1,758,400	6,001	853,776	2,914	$22,436	$0.026	$7.70	2,563	$32,216	12.57	$54,652	$0.064	$18.76
Dec-95	77,672	$203,264	$2.62	1,618,400	5,524	1,058,904	3,614	$30,861	$0.029	$8.54	2,227	$27,993	12.57	$58,853	$0.056	$16.28
Jan-96	83,246	$233,524	$2.81	1,713,600	5,849	1,142,064	3,898	$26,411	$0.023	$6.78	2,673	$32,838	12.29	$59,249	$0.052	$15.20
Totals	612,931	$1,723,589	$2.81	24,953,600	85,167	17,008,992	58,052	$497,884	$0.029	$8.58	36,864	$477,056	12.94	$974,939	$0.057	$16.79
Averages	51,078	$143,632				1,417,416	4,838	$41,490			3,072	$39,755		$81,245		

Existing Conditions

	MBtu	Cost
Natural Gas	612,931	$1,723,589
Electricity	58,052	$974,939
Totals	670,983	$2,698,528

Savings From ECO's

NG Savings	195,760	MBtu/Year
Elec. Svgs	5,916	MBtu/Year

After ECO's Implemented

	MBtu	Cost	
Natural Gas	417,171	$1,173,103	$2.81
Electricity	52,136	$875,584	$16.79
Totals	469,307	$2,048,687	

Pine Bluff Arsenal - Electrical Demand and Heating Study
Natural Gas Bill Calculations
Filename: NGASBILL.XLS

	Natural Gas Use			
Mon-Yr	MBtu	$	$/MBtu	
Feb-95	65,166	$169,839	$2.61	
Mar-95	58,220	$160,030	$2.75	
Apr-95	44,683	$135,613	$3.03	Billed for additional $7,200 for use/contract imbalance.
May-95	37,697	$111,964	$2.97	
Jun-95	38,392	$113,603	$2.96	
Jul-95	37,838	$110,372	$2.92	
Aug-95	34,199	$102,086	$2.99	
Sep-95	35,284	$104,505	$2.96	
Oct-95	41,937	$119,834	$2.86	
Nov-95	58,597	$158,956	$2.71	
Dec-95	77,672	$203,264	$2.62	
Jan-96	83,246	$233,524	$2.81	
Totals	612,931	$1,723,589	$2.81	
Averages	51,078	$143,632	$2.85	

Pine Bluff Arsenal - Electrical Demand and Heating Study
Electric Bill Calculations
Filename: ELECBILL.XLS

	Electric Energy Use			Electric Demand			Overall	
Mon-Yr	kWh	$	$/kWh	kW	$	$/kW	Total $	$/kWh
Feb-95	1483020	$39,370	0.02655	2385	$29,979	12.57	$69,349	0.04676
Mar-95	1405404	$35,972	0.02560	2449	$30,783	12.57	$66,755	0.04750
Apr-95	1602216	$41,084	0.02564	2249	$33,923	15.08	$75,007	0.04681
May-95	1069992	$34,997	0.03271	2696	$27,818	10.32	$62,814	0.05871
Jun-95	1552320	$54,138	0.03488	2730	$37,829	13.86	$91,967	0.05924
Jul-95	1804572	$64,411	0.03569	4104	$57,162	13.93	$121,572	0.06737
Aug-95	1876644	$63,548	0.03386	4236	$59,019	13.93	$122,568	0.06531
Sep-95	1907136	$50,930	0.02671	5156	$64,809	12.57	$115,740	0.06069
Oct-95	1252944	$33,727	0.02692	3396	$42,687	12.57	$76,414	0.06099
Nov-95	853776	$22,436	0.02628	2563	$32,216	12.57	$54,652	0.06401
Dec-95	1058904	$30,861	0.02914	2227	$27,993	12.57	$58,853	0.05558
Jan-96	1142064	$26,411	0.02313	2673	$32,838	12.29	$59,249	0.05188
Totals	17008992	$497,884	0.02927	36864	$477,056	12.94	$974,939	0.05732
Averages	1417416	$41,490	0.02892	3072	$39,755	12.90	$81,245	0.05707

Pine Bluff Arsenal - Electrical Demand and Heating Study
Electric Bill Calculations
Filename: ELECBILL.XLS

	Electric Energy Use			Electric Demand			Overall	
Mon-Yr	kWh	$	$/kWh	kW	$	$/kW	Total $	$/kWh
Feb-95	1,483,020	$39,370	0.02655	2,385	$29,979	12.57	$69,349	0.04676
Mar-95	1,405,404	$35,972	0.02560	2,449	$30,783	12.57	$66,755	0.04750
Apr-95	1,602,216	$41,084	0.02564	2,249	$33,923	15.08	$75,007	0.04681
May-95	1,069,992	$34,997	0.03271	2,696	$27,818	10.32	$62,814	0.05871
Jun-95	1,552,320	$54,138	0.03488	2,730	$37,829	13.86	$91,967	0.05924
Jul-95	1,804,572	$64,411	0.03569	4,104	$57,162	13.93	$121,572	0.06737
Aug-95	1,876,644	$63,548	0.03386	4,236	$59,019	13.93	$122,568	0.06531
Sep-95	1,907,136	$50,930	0.02671	5,156	$64,809	12.57	$115,740	0.06069
Oct-95	1,252,944	$33,727	0.02692	3,396	$42,687	12.57	$76,414	0.06099
Nov-95	853,776	$22,436	0.02628	2,563	$32,216	12.57	$54,652	0.06401
Dec-95	1,058,904	$30,861	0.02914	2,227	$27,993	12.57	$58,853	0.05558
Jan-96	1,142,064	$26,411	0.02313	2,673	$32,838	12.29	$59,249	0.05188
Totals	17,008,992	$497,884	0.02927	36,864	$477,056	12.94	$974,939	0.05732
Averages	1,417,416	$41,490	0.02892	3,072	$39,755	12.90	$81,245	0.05707

With 1996 Rates:

	Electric Energy Use			Electric Demand			Overall	
Mon-Yr	kWh	$	$/kWh	kW	$	$/kW	Total $	$/kWh
Feb-95	1,483,020	$39,370	0.02655	2,385	$29,191	12.24	$68,561	0.04623
Mar-95	1,405,404	$35,972	0.02560	2,449	$29,974	12.24	$65,946	0.04692
Apr-95	1,602,216	$41,084	0.02564	2,249	$33,032	14.69	$74,116	0.04626
May-95	1,069,992	$34,997	0.03271	2,696	$27,165	10.08	$62,161	0.05810
Jun-95	1,552,320	$54,138	0.03488	2,730	$36,927	13.53	$91,065	0.05866
Jul-95	1,804,572	$64,411	0.03569	4,104	$55,807	13.60	$120,217	0.06662
Aug-95	1,876,644	$63,548	0.03386	4,236	$57,620	13.60	$121,169	0.06457
Sep-95	1,907,136	$50,930	0.02671	5,156	$63,107	12.24	$114,037	0.05979
Oct-95	1,252,944	$33,727	0.02692	3,396	$41,565	12.24	$75,292	0.06009
Nov-95	853,776	$22,436	0.02628	2,563	$31,370	12.24	$53,806	0.06302
Dec-95	1,058,904	$30,861	0.02914	2,227	$27,257	12.24	$58,118	0.05488
Jan-96	1,142,064	$26,411	0.02313	2,673	$32,716	12.24	$59,127	0.05177
Totals	17,008,992	$497,884	0.02927	36,864	$465,731	12.63	$963,615	0.05665
Averages	1,417,416	$41,490	0.02892	3,072	$38,811	12.60	$80,301	0.05641

14 February 1996

Pine Bluff Arsenal Consumption
for
Natural Gas and Electricity

Date	Natural Gas MBTUs	Electricity KWH
February 1995	65,166	2,058,000
March 1995	58,220	1,946,000
April 1995	47,855	2,189,600
May 1995	37,697	1,517,600
June 1995	38,392	2,240,000
July 1995	37,838	2,651,600
August 1995	34,199	2,769,200
September 1995	35,284	2,699,200
October 1995	41,937	1,792,000
November 1995	58,597	1,758,400
December 1995	77,672	1,618,400
January 1996	83,246	1,713,600

A.7 SUBMITTAL REVIEW COMMENTS AND REVIEW ACTIONS

RS&H
Reynolds, Smith and Hills, Inc.
Architectural, Engineering, Planning and Environmental Services

Response to Review Comments

Date: August 8, 1996

Reviewer: Anthony W. Battaglia
U.S. Army Engineer District, Mobile

Response by: William T. Todd, PE

Subject: Interim Submittal
Combined Energy Study, Electric and Heating, Pine Bluff Arsenal, AR
DACA01-94-D-0038/0004, RSH #694-1331-004

Number	Dwg/Pg/Par.	Response	Review Action Comments
1	General	Concur	Thank you.
2	Vol. I Pg. 3-2	Concur	This statement will be changed to read "properly functioning gas flow meters".
3	Vol. I Pg. 3-3	Concur	A discussion on how the comfort heating energy (CH_P) was calculated will be added to Section 3.2.
4	Vol. I Pg. 4-2	Concur	Will change the text in the ECO-C3 title from "steam distribution" to "compressed air".
5	Vol. I Pg. 4-6	Concur	Will change the second "42-010" in the ECO-E3 title to "42-020".
6	ECO's H2B, H3B & H4B	Exception	Based on our observations, the jack shaft drives, connecting links, lever arms and cams all appear in good operational condition. Therefore, it should not be necessary to upgrade any additional boiler components.
7	Vol. I Pg. 4-15	Exception	The existing boilers have been modified to operate at about 200% of their rated capacity. During 1995 the existing boilers operated between 60% and 175% of their rated capacity and an annual average

			load factor of about 110%. This means the York-Shipley boilers will operate between 30% and 90% of their rated capacity. These boilers are already equipped with controls that will allow them to operate at an efficiency of about 80% from full load down to about 10% to 20% of full load.
8	Vol. I Pg. 5-3	Concur	Will remove ECO-H1B from Table 5.3-1 and Table 5.3-2. This project was included because Paragraph 5.2 of the Scope of Work does not require a payback of less than 10 years for non-ECIP projects.
9	Vol. I Pg. 5-8	Concur	Will delete "about" from the first sentence since an exact number of compressed air leaks has not been determined.

CC: C. Warren
File

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...ICT PROJECT REVIEW COMMENTS:	DATE: 10 July 1996	Page 1 of 1
...ineering, CESWL-ED-DE, ...Rock District	FROM: Anthony W. Battaglia, CESAM-EN-DM Phone: (334) 690-2618 FAX: (334) 690-2424	
...T/FY: FY95 Combined Limited Energy Study		
...TION: Pine Bluff Arsenal, Arkansas		
...B REVIEW: Interim Submittal		

NO.	Page/Par	COMMENT	Response to Comment
1.	General	This is a good effort; and the AE is commended not only for observing the excessive steam leaks, but also for the approach used in quantifying them and calculating the potential enegy savings.	
2.	Pg 3-2	Do not understand the term, "plurality functioning gas flow meters"; please clarify.	
3.	Pg 3-3	Please include a discussion of how the quantity, "CHp" is determined.	
4.	Pg 4-2	ECO-C3: Change "steam" to "air".	
5.	Pg 4-6	First line: Change one of the "42-010's" to "42-020".	
6.	ECO-H2 through ECO-H4	In Option B of these ECOs, the approach is to add an adjustable cam (O_2 Trim Control?) to the fuel-air linkage of the existing boilers. This is a good idea, but more consideration should be given to the age of the boilers. Even the "new" forced draft fans are probably pretty old. To make the new controls work properly, some of the existing components may have to be upgraded or replaced. It is suggested that the 10% contingency used in the cost estimate may not be sufficient. Please investigate and revise as needed.	
7.	Pg 4-15	ECO-H2, Option C: The new York-Shipley boilers each have a capacity of 600 hp, approximately double the capacity of the existing boilers. I assume these boilers would operate considerably below their rated capacity; would the 80% efficiency still be appropriate for this condition?	
8.	Pg 5-3	Tables 5.3-1 & 5.3-2: Since ECO H1-B has a simple payback period greater than 10 years, it should not be recommended.	
9.	Pg 5-8	Compressed Air Distribution: Add the quantity of compressed air leaks to the second sentence.	

RS&H
Reynolds, Smith and Hills, Inc.
Architectural, Engineering, Planning and Environmental Services

Response to Review Comments

Date: August 8, 1996

Reviewer: Ralph Rimmer
Pine Bluff Arsenal, DPW Technical Coordinator

Response by: William T. Todd, PE

Subject: Interim Submittal
Combined Energy Study, Electric and Heating, Pine Bluff Arsenal, AR
DACA01-94-D-0038/0004, RSH #694-1331-004

Number	Dwg/Pg/Par.	Response	Review Action Comments
1	Vol. II Pg. A.5.E3-6	Exception	During a telephone conversation, Ralph indicated the effect of operating the existing induction motors at 480 volts (which is higher than their nameplate rating of 440 volts) might cause the efficiency to decrease. The savings for installing energy efficient motors would then be higher than the values calculated for ECO-E3. According to page 2-6 of the <u>Motor Application and Maintenance Handbook</u> (see attached copy): The efficiency of a motor at 3/4 load decreases by 0.5 - 2.0% at 120% of rated voltage and the efficiency is not affected when operating at 110% of rated voltage. The operating voltage at PBA is 480 V, which is 480/440 = 1.09% of the rated voltage. Therefore, the efficiency of the motors should not vary too much.

CC: C. Warren
File

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TABLE 2. General Effect of Voltage and Frequency Variation on Induction-motor Characteristics

Variation	Starting and max running torque	Synchronous speed	% slip	Full-load speed	Efficiency: Full load	Efficiency: 3/4 load	Efficiency: 1/2 load	Power factor: Full load	Power factor: 3/4 load	Power factor: 1/2 load	Full-load current	Starting current	Temp rise, full load	Max overload capacity	Magnetic noise—no load in particular
Voltage variation:															
120% voltage	Increase 44%	No change	Decrease 30%	Increase 1.5%	Small increase	Decrease 1/2–2 points	Decrease 7–20 points	Decrease 5–15 points	Decrease 10–30 points	Decrease 15–40 points	Decrease 11%	Increase 25%	Decrease 5–6°C	Increase 44%	Noticeable increase
110% voltage	Increase 21%	No change	Decrease 17%	Increase 1%	Increase 1/2–1 point	Practically no change	Decrease 1–2 points	Decrease 3 points	Decrease 4 points	Decrease 5–6 points	Decrease 7%	Increase 10–12%	Decrease 3–4°C	Increase 21%	Increase slightly
Function of voltage	$(\text{Voltage})^2$	Constant	$\frac{1}{(\text{voltage})^2}$	(Synchronous speed slip)								Voltage		$(\text{Voltage})^2$	
90% voltage	Decrease 19%	No change	Increase 23%	Decrease 1 1/2%	Decrease 2 points	Practically no change	Increase 1–2 points	Increase 1 point	Increase 2–3 points	Increase 4–5 points	Increase 11%	Decrease 10–12%	Increase 6–7°C	Decrease 19%	Decrease slightly
Frequency variation:															
105% frequency	Decrease 10%	Increase 5%	Practically no change	Increase 5%	Slight increase	Slight increase	Slight increase	Slight increase	Slight increase	Slight increase	Decrease slightly	Decrease 5–6%	Decrease slightly	Decrease slightly	Decrease slightly
Function of frequency	$\frac{1}{(\text{frequency})^2}$	Frequency		(Synchronous speed slip)								$\frac{1}{\text{frequency}}$			
95% frequency	Increase 11%	Decrease 5%	Practically no change	Decrease 5%	Slight decrease	Slight decrease	Slight decrease	Slight decrease	Slight decrease	Slight decrease	Increase slightly	Increase 5–6%	Increase slightly	Increase slightly	Increase slightly

Note. This table shows general effects, which will vary somewhat for specific ratings.

Response to Review Comments

Date: August 14, 1996

Reviewer: PBA: Don Faust , Nancy Rimmer, Gene Thomas and Kurt Williams
U.S. Army Engineer District, Little Rock: Exa Hartman & Joe Martinez

Response by: William T. Todd, PE

Subject: Interim Submittal
Combined Energy Study, Electric and Heating, Pine Bluff Arsenal, AR
DACA01-94-D-0038/0004, RSH #694-1331-004

Number	Dwg/Pg/Par.	Response	Review Action Comments
2	ECO-E4	Concur	A statement will be added to the recommendations for ECO-E4 in Volume I, Section 4 that states this ECO is not recommended because the equipment is going to be replaced before the payback period. This ECO will also be removed from Tables 5.3-1 and 5.3-2. Project documentation will not be prepared for ECO-E4.
3	ECO-E5	Concur	Project documentation will not be prepared for ECO-E5.
4	ECO-H2B & ECO-H2C	Concur	A statement will be added to the recommendations for these ECO's in Volume I, Section 4 that states these ECO's are not recommended because the boilers are being replaced before the payback period. ECO-H2B and ECO-H2C will be removed from Tables 5.3-1 and 5.3-2 and project documentation will not be prepared for these ECO's.
5	ECO-H2	Exception	We think it would be wise to include an ECO to install the economizers as a retrofit project just in case they can not be included in the current construction project. Unless directed otherwise, we will

			analyze installing economizers and adding the results as ECO-H2, Option D.
6	ECO-H4	Concur	ECO-H4C will be eliminated and the cost and savings associated with the deaerator installation will be combined with the cost and savings of adding controls to maintain the proper air-fuel ratio. The results will be presented in the report as ECO-H4B.
7	ECO-H3 & ECO-H4	Concur	We will analyze the feasibility of installing economizers for the boilers in Buildings 33-060 and 34-140. These analyses will be included in the report as ECO-H3C and ECO-H4C, respectively.
8	Programming Documents	NA	Based on the type of ECO's that were recommended, and information from Tony Battaglia, we recommend the ECO's be packaged separately for FEMP funding. Programming documentation (ECIP or FEMP) will be prepared and included with the Final Submittal after PBA decides how to package the ECO's.
9	Vol. II Section 1	Concur	Page 5 and Amendment Number 1 will be included in the copy of the Scope of Work for the Final Submittal.
10	General	Concur	Both Exa Hartman and Joe Martinez will receive a Copy of the Final Submittal.

CC: C. Warren
File

RS&H
Reynolds, Smith and Hills, Inc.
Architectural, Engineering, Planning and Environmental Services

Meeting Notes

Date: August 8, 1996

Meeting Date: August 6, 1996

Location: DPW Offices, Pine Bluff Arsenal, AR

Attendees: PBA: Don Faust, Nancy Rimmer, Gene Thomas and Kurt Williams
U.S. Army Engineer District, Little Rock: Exa Hartman & Joe Martinez
Reynolds, Smith and Hills, Inc.: George Fallon and Bill Todd

Notes by: William T. Todd, PE

Subject: Interim Submittal Review
Combined Energy Study, Electric and Heating, Pine Bluff Arsenal, AR
DACA01-94-D-0038/0004, RSH #694-1331-004

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1. Bill Todd opened the meeting and provided a handout to each person that included a summary of the presentation along with tables and graphs. Bill Todd and George Fallon gave an overview of the study including the objectives of the study, the methodology used and results of the ECO evaluations. During the presentation, the personnel in attendance were given ample opportunity to ask questions and discuss the study.

2. Don Faust indicated the four existing filtered water pumps, motors and associated piping are scheduled to be replaced with two new larger pumps and motors. ECO-E4 (energy efficient motors) should not be recommended and project documentation should not be prepared for this ECO.

3. Gene Thomas confirmed that the incinerator scrubber system is scheduled to be replaced soon. ECO-E5 (energy efficient motors) should not be recommended and project documentation should not be prepared for this ECO.

4. The PBA DPW staff indicated that PBA has acquired the funds and the boilers in Building 32-060 are currently being demolished to make room for the two surplus York-Shipley boilers. ECO-H2B (boiler efficiency improvements) and ECO-H2C (install surplus boilers) should not be recommended and project documentation should not be prepared for these ECO's.

5. A discussion of adding an ECO that would analyze the installation of economizers on the York-Shipley boilers resulted in Gene Thomas indicating that PBA would try to include the economizers in the current construction project.

6. The PBA DPW staff requested ECO-H4B (improve boiler efficiency) and ECO-H4C (install deaerator) be combined into one ECO. This would combine a recommended ECO with an non-recommended ECO to create one ECO that qualifies for funding.

7. The PBA DPW staff requested that RS&H look at the feasibility of adding economizers to the existing boilers in Buildings 33-060 and 34-140.

8. The PBA DPW staff was not sure how they wanted to package the recommended ECO's into projects for implementation.

   Bill Todd placed a telephone call to Tony Battaglia of the U.S. Army Engineer District, Mobile, for clarification and assistance with the various funding choices. Tony indicated the two choices were the Energy Conservation Investment Program (ECIP) and the Federal Energy Management Program (FEMP). Tony thought that FEMP projects were more likely to be funded than ECIP projects at this point in time.

   ECIP is part of the Military Construction, Army (MCA) program and requires a project cost of over $300,000. FEMP is part of the Operations and Maintenance, Army (OMA) account for funding energy conservation projects. FEMP projects must result in needed maintenance or repair to an existing facility or replace a failing or failed system or component. There is no minimum cost limitation for FEMP projects.

   The PBA DPW staff will review the available programming options and advise RS&H as to how they prefer the recommended ECO's to be packaged into projects for implementation on or before 8/14/96. How the ECO's are combined will determine if the project or projects will be documented for ECIP or FEMP funding.

9. Exa Hartman indicated that page 5 and Amendment Number 1 of the Scope of Work were not included in Volume II, Section 1. These items should be added for the Final Submittal.

10. The report does not have to be separated into two separate documents, however, both Exa Hartman and Joe Martinez should receive a copy of the Final Submittal.

11. RS&H will provide a response and proposed action for all Interim Submittal review comments to Joe Martinez on or before 8/19/96.

CC: C. Warren
File

M:\ENERGY\PBA96\MTG8-6.DOC

A.8 CORRESPONDENCE AND MEETING NOTES

ORDER FOR SUPPLIES OR SERVICES
(Contractor must submit four copies of invoice)

Form Approved
OMB No. 0704-0187
Expires Aug 31, 1992

PAGE 1 OF

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0187), Washington, DC 20503. Please DO NOT RETURN your form to either of these addresses. Send your completed form to the procurement official identified in item 6.

1. CONTRACT / PURCH ORDER NO: DACA01-94-D-0038
2. DELIVERY ORDER NO.: 0004
3. DATE OF ORDER: 93 Sep 12
4. REQUISITION / PURCH REQUEST NO.:
5. CERTIFIED FOR NATIONAL DEFENSE UNDER DMS REG 1: DO

6. ISSUED BY CODE
US ARMY ENGINEER DISTRICT, MOBILE
P.O. BOX 2288
MOBILE, ALABAMA 36628-0001

7. ADMINISTERED BY (If other than 6) CODE
US ARMY ENGINEER DISTRICT, LITTLE ROCK
P.O. BOX 867
LITTLE ROCK, AR 72203-0867

8. DELIVERY FOB
[X] DEST
[ ] OTHER
(See Schedule if other)

9. CONTRACTOR CODE FACILITY CODE
NAME AND ADDRESS
REYNOLDS, SMITH AND HILLS, INC.
4651 SALISBURY ROAD
JACKSONVILLE, FLORIDA 32256

10. DELIVER TO FOB POINT BY (Date): SEE APPENDIX "A"
11. MARK IF BUSINESS IS
[ ] SMALL
[ ] SMALL DISADVANTAGED
[ ] WOMEN-OWNED
12. DISCOUNT TERMS
13. MAIL INVOICES TO: SEE BLOCK #14

14. SHIP TO CODE
US ARMY ENGINEER DISTRICT, LITTLE ROCK
ATTN: CESWL-ED-DE (ANGEL)
P.O. BOX 867
LITTLE ROCK, AR 72203-0867

15. PAYMENT WILL BE MADE BY CODE
FINANCE AND ACCOUNTING OFFICER
US ARMY ENGINEER DISTRICT, LITTLE ROCK
P.O. BOX 867 ATTN: RM-F (T. HARRIS)
LITTLE ROCK, AR 72203-0867

MARK ALL PACKAGES AND PAPERS WITH CONTRACT OR ORDER NUMBER

16. TYPE OF ORDER
DELIVERY — This delivery order is issued on another Government agency or in accordance with and subject to terms and conditions of above numbered contract.
PURCHASE — Reference your furnish the following on terms specified herein.

ACCEPTANCE. THE CONTRACTOR HEREBY ACCEPTS THE OFFER REPRESENTED BY THE NUMBERED PURCHASE ORDER AS IT MAY PREVIOUSLY HAVE BEEN OR IS NOW MODIFIED, SUBJECT TO ALL OF THE TERMS AND CONDITIONS SET FORTH, AND AGREES TO PERFORM THE SAME.

NAME OF CONTRACTOR | SIGNATURE | TYPED NAME AND TITLE | DATE SIGNED

[ ] If this box is marked, supplier must sign Acceptance and return the following number of copies:

17. ACCOUNTING AND APPROPRIATION DATA / LOCAL USE
2152050 08-8071 P7000 S34066 RA521250001B400 $92,554.00 TOTAL DIRECT CITE ORG: NT

18. ITEM NO.	19. SCHEDULE OF SUPPLIES / SERVICE	20. QUANTITY ORDERED/ ACCEPTED*	21. UNIT	22. UNIT PRICE	23. AMOUNT
0001	DELIVERY ORDER FOR ENERGY ENGINEERING ANALYSIS PROGRAM (EEAP) ELECTRICAL ENERGY DEMAND AND USAGE AND HEATING STUDY (COMBINED LIMITED ENERGY STUDY), PINE BLUFF ARSENAL, AR PTAC 6690	1	JOB		$92,554.00

*If quantity accepted by the Government is same as quantity ordered, indicate by X. If different, enter actual quantity accepted below quantity ordered and encircle.

24. UNITED STATES OF AMERICA
Gene L Curtis
BY: GENE L. CURTIS
CONTRACTING / ORDERING OFFICER

25. TOTAL: $92,554.00
29. DIFFERENCE

26. QUANTITY IN COLUMN 20 HAS BEEN
[ ] INSPECTED [ ] RECEIVED [ ] ACCEPTED, AND CONFORMS TO THE CONTRACT EXCEPT AS NOTED

DATE | SIGNATURE OF AUTHORIZED GOVERNMENT REPRESENTATIVE

27. SHIP NO.
[ ] PARTIAL
[ ] FINAL
28. D.O. VOUCHER NO.
30. INITIALS
32. PAID BY
33. AMOUNT VERIFIED CORRECT FOR
34. CHECK NUMBER
35. BILL OF LADING NO.

36. I certify this account is correct and proper for payment
DATE | SIGNATURE AND TITLE OF CERTIFYING OFFICER

31. PAYMENT
[ ] COMPLETE
[ ] PARTIAL
[ ] FINAL

37. RECEIVED AT | 38. RECEIVED BY | 39. DATE RECEIVED | 40. TOTAL CONTAINERS | 41. S/R ACCOUNT NUMBER | 42. S/R VOUCHER NUMBER

PBA

PRE-SURVEY NOTES

12/13/95

BLDG 32-060

1. PROJECT IN-HOUSE TO REPLACE 2 BOILERS
W/2-600 HP BOILERS ON PADS NEXT TO BLDG.

2. 2 COMPRESSORS GE RECIPS

NOTE: 6 COMPRESSORS (2 EA IN BLDGS 32-060, 33-060 & 34-140) MANIFOLDED TO SUPPLY ~ 120 PSI AIR TO PRODUCTION AREAS.

CONTROLS ARE MANUAL; OPERATORS STAGE ACCORDING TO PRESSURE READINGS — LOGS ARE AVAILABLE

BLDG 33-060

1. BOILERS (2) ARE B&W, ~1941 VINTAGE. ORIGINALLY 375 HP EA.

DESIGNED AS DOUBLE-PASS - APPROX 25 YRS AGO, BURNERS WERE MOVED TO OPPOSITE END OF BOILERS.

STACKS HAVE ACCESS PORTS

HIGH STACK TEMPS ~ 700-1100°F

DAILY LOGS / STEAM FLOW CHARTS ARE AVAILABLE FOR ONE YR.

ASBESTOS PRESENT

2. COMPRESSORS (SEE BLDG 32-060)

PBA NOTES 12/13/95

BLDG 34-140

1. BOILERS WERE DOWN FOR ASBESTOS PROBLEM
2. COMPRESSORS (2) - SEE BLDG 32-060

BLDG 44-120

1. CLEAVER-BROOKS PACKAGE BOILERS (2) 75 HP EA

(1) 6-7 YRS OLD
(1) 26 YRS OLD

NO STACK PORTS

GAS READINGS TAKEN ONCE PER 24 HRS - CONVERTED TO STEAM VIA FORMULA

BLDG 42-960

1. AZTEC PACKAGE BOILERS (2) 1978 VINTAGE

NO STACK PORTS

STEAM FORMULA FROM GAS READINGS 1/24 HRS

PBA NOTES 12/13/95

BLDG 42-979

1. DRAFT FAN FOR INCINERATOR
   350 HP
   RUNS 24 HRS/DA – 7 DA/WK
   TECO 460V 382A 1785 RPM
   # FF C56611-1

BLDG 42-010

1. WATER WELL PUMP
   150 HP
   CHARTS AVAILABLE BLDG 42-210

BLDG 42-210

1. 4 PUMPS FOR LIFTING WATER TO TANKS
   30 HP EA
   LIFT 700 GAL/MIN
   CHARTS AVAILABLE

BLDG 34-196

1. VENT FANS (2) FOR WP PRODUCTION AREA BLDG 34-110
   800 HP EA 1978 VINTAGE
   RUN DURING PRODUCTION ~12 HR/DAY (NEED PROD. SCHEDULE)

ONLY ONE RUNS AT A TIME

RS&H

Reynolds, Smith and Hills, Inc.

MEMORANDUM ***Architectural, Engineering, Planning and Environmental Services***

To:	Distribution	**Date:** 14 December 1995
From:	Carlos S. Warren, PhD, PE Project Manager	
Project:	Energy Engineering Analysis Program (EEAP) Combined Limited Energy Study - Pine Bluff Arsenal Contract No. DACA01-94-D-0038/0004 A/E No. 694-1331-004	
Subject:	Preliminary Site Survey Meeting Minutes	

A preliminary site survey meeting was held at Pine Bluff Arsenal (PBA) on 13 December 1995. The purpose of the meeting was to clarify the project scope of work (SOW) in light of construction projects that have been initiated at PBA.

Attendees were Nancy Rimmer, Kirk Williams and Donald Faust of PBA; Mark Emmerling, Exa Hartman and Joe Martinez of the Corps of Engineers, Little Rock; and Carlos Warren of Reynolds, Smith and Hills.

The following no-cost modifications to the SOW were agreed to by the participants:

1. Four water service pumps housed in building 42-210 will be added to the list for survey and ECO evaluation for electrical energy demand and usage.

2. A project is underway to replace the two B & W boilers in building 32-060 (Main Boiler Plant #2) with the two new 600 HP package boilers presently on hand. The SOW requirement to test and evaluate the boilers will be deleted and testing and evaluation of two boilers in building 42-960 will be added.

3. In addition to testing and evaluation of the three boilers in building 34-140 (Main Boiler Plant #4), adding a deaerator to the building will be evaluated.

4. Testing and evaluation of two boilers in building 44-120 will be added to the SOW; evaluation of installing gas fired furnaces to replace boilers in building 13-120 will be deleted.

5. Evaluation of replacing the boiler with a gas furnace in building 63-100 will be deleted from the SOW; Investigation of retrofitting the new boilers to be installed in building 32-060 with economizers will be added.

6. At the present time, six compressors are used to supply the production areas. Investigation of (1) adding the two on-hand compressors to the six in-service , or (2) replacing two of the old compressors with the new ones will be added to the SOW.

Other items:

1. Monthly progress reports will be submitted simultaneously with pay requests.

2. Project schedule will be submitted by 22 December.

3. Project effort schedule will be submitted to Little Rock by 29 December.

4. Little Rock will draft the modifications to the SOW and forward to the appropriate authorities for approval.

The balance of the meeting was devoted to walk - through surveys of the SOW sites.

Distribution:

Commander
U.S. Army, Pine Bluff Arsenal
Attn: SMCPB-EHN (Ms. Rimmer)
10020 Kabrich Circle
Pine Bluff, AR 71602-9500

Commander
U.S. Army Engineer District, Little Rock
Attn: CESWL-ED-DM (Ms. Hartman)
700 W. Capitol
P.O. Box 867
Little Rock, AR 72203-0867

Commander
U.S. Army Engineer District, Little Rock
Attn: CESWL-ED-DM (Mr. Martinez)
700 W. Capitol
P.O. Box 867
Little Rock, AR 72203-0867

Commander
U.S. Army Engineer District, Mobile
Attn: CESAM-EN-CM (Mr. Battaglia)
P.O. Box 2288
Mobile, AL 36628

RS&H

Reynolds, Smith and Hills, Inc.
Architectural, Engineering, Planning and Environmental Services

Memorandum

Date: January 8, 1996

To: US Army Engineer District, Little Rock
ATTN: CESWL-ED-DM (Mr. Mark Emmerling)
P. O. Box 867
Little Rock, AR 72203-0867

From: Carlos S. Warren, PhD, PE
Project Manager

Subject: Monthly Progress Report
Contract No. DACA01-94-0038/0004
Electrical Energy Demand and Usage and Heating Study
Pine Bluff Arsenal, Arkansas

The following progress was made on the subject project during the month of December 1995:

1. A Scope of Work definition meeting and preliminary site survey were conducted at the Arsenal on 13 December 1995. Attendees were Mark Emmerling, Exa Hartman and Joe Martinez of LRCOE, Nancy Rimmer, Kirk Williams and Donald Faust of PBA, and Carlos Warren of RS&H.

2. A detailed project schedule was developed and is enclosed with this report.

Work planned for January 1996:

1. The detailed site survey is scheduled for 29 January - 1 February 1996. In addition to the Project Manager, two engineers will participate in the survey, one for the electrical and one for the boilers.

2. PBA personnel will be required to accompany the engineers, particularly someone from the electric shop.

3. Entrance and exit interviews are scheduled for 1330 hours 29 January and 1300 hours February, respectively.

Copies to: N. Rimmer, Pine Bluff Arsenal
E. Hartman, US Army Engineer District, Little Rock
J. Martinez, US Army Engineer District, Little Rock
T. Battaglia, US Army Engineer District, Mobile

COMPUTATION SHEET

SUBJECT: Entrance Interview

COMPUTATION: Sign - In

FILE NO.

COMPUTED BY

DATE: 1/29/96

CHECKED BY

DATE

(1) Exa P. Hartman	CESWL-ED-DM	324-6153
George Fallon	RS&H	904-279-2275
Carlos S. Warren	RS&H	904-279-2275
Lanny Evans	RS&H	904 279 2393
[illegible] Fost	SIOPB-PWE	([illegible]) [illegible]
Nancy Rimmer	SIOPB-PWN	(501) 540-3312

SWD FORM 521
3 FEB 88

1/29/96

① ~~Between Mo~~
By Mar 3 submit pay request for Interim Submittal & this site survey

Mar
Apr invoice

② Incinerator started in Feb - gas consumption prior to Feb will not reflect.

Due to have an increase later in year

C.B. Huggins 3035

③ Gary Turner - boiler mech 3337

④ Write up minutes of entrance interviews & exit interview

RS&H
Reynolds, Smith and Hills, Inc.
Architectural, Engineering, Planning and Environmental Services

Memorandum

Date: February 8, 1996

To: US Army Engineer District, Little Rock
ATTN: CESWL-ED-DM (Mr. Mark Emmerling)
P. O. Box 867
Little Rock, AR 72203-0867

From: Carlos S. Warren, PhD, PE Carlos S. Warren
Project Manager

Subject: Monthly Progress Report
Contract No. DACA01-94-0038/0004
Electrical Energy Demand and Usage and Heating Study
Pine Bluff Arsenal, Arkansas

The following progress was made on the subject project during the month of January 1996:

1. The site survey scheduled for the week of 29 January was completed, except for the Exit Interview. Inclement weather caused the survey team to leave a day earlier than scheduled, but all data specifications in the Scope of Work were completed. It was agreed by PBA (Ms. Rimmer) that the Exit Interview materials would be included in this month's progress report (see enclosure)

2. The minutes of the Entrance Interview are also enclosed with this progress report.

Work planned for February 1996:

1. Begin analysis of survey data.

2. Begin preparation of Interim Report (due 26 April).

Copies to: N. Rimmer, Pine Bluff Arsenal
E. Hartman, US Army Engineer District, Little Rock
J. Martinez, US Army Engineer District, Little Rock
T. Battaglia, US Army Engineer District, Mobile

A.8-10

encl. 1

ENTRANCE INTERVIEW MINUTES
SITE SURVEY - PINE BLUFF ARSENAL
29 JANUARY 1966

The Entrance Interview for the PBA Electrical Energy Demand and Usage and Heating Study Site Survey was held at Pine Bluff Arsenal at 1330 hours, 29 January 1996. Present for the meeting were the following:

Name	Organization	Telephone #
Exa Hartman	CESWL-ED-DM	501-324-6153
Donald Faust	SIOPB-PWE	501-540-3253
Nancy Rimmer	SIOPB-PWN	501-540-3312
Carlos Warren	RS&H	904-279-2275
William (Lanny) Evans	RS&H	904-279-2393
George Fallon	RS&H	904-279-2275

The following topics were discussed:

1. The Scope of Work (SOW) was reviewed by the meeting participants and the plan for the survey was outlined by Dr. Warren. Mr. Evans and Mr. Fallon would take measurements on the boilers and compressors, and Dr. Warren would take data on the motors as listed in the SOW.

2. PBA would provide an electrician to accompany Dr. Warren.

3. A request was made by Dr. Warren for PBA (Ms. Rimmer) to provide electrical and thermal energy consumption and cost for the past year. Demand data for typical weeks during the year was also requested, plus WP production schedules. Ms. Rimmer agreed to provide the data.

4. Because of an upcoming change in the COE accounting system, Ms. Hartman asked that RS&H submit the pay requests for March and April in advance, by March 3. Dr. Warren agreed to do so.

The meeting was adjourned at approximately 1500 hours.

encl. 2

SITE SURVEY RESULTS
PINE BLUFF ARSENAL ELECTRICAL ENERGY DEMAND AND USAGE AND HEATING STUDY
29 - 30 JANUARY 1996

Boiler Survey

Stack gas analysis was conducted on the boilers operating in five buildings. Even though the two boilers in Building 32060 were deleted from the Scope of Work, tests were made in case plans are changed to take the boilers off line.

All the boilers are single burner, forced draft, natural gas/ No. 2 fuel oil fired, with the fuel and air mechanically linked. Natural gas is the primary fuel; No. 2 fuel oil is rarely burned. Table 1 below lists the stack gas test results.

Table 1: Stack gas analysis results.

Bldg.. No.	Boiler No.	Stack O_2 (%)	Excess Air (%)	Eff. (%)
32060	1	12.0	122	74.3
32060	2	12.4	129	72.5
33060	1	12.0	122	73.7
33060	2	Down	Down	Down
34140	1	8.7	63	71.5
34140	2	Down	Down	Down
34140	3	14.1	184	66.9
42960	1	1.6	7	79.2
42960	2	Down	Down	Down
44120	1	4.3	23	83.1
44120	2	Down	Down	Down

With the exception of the boiler in building 42690, all of the units are using excessive amounts of combustion air. Generally, single burner, natural gas fired boilers can be successfully and safely operated at 10 - 15 % excess air.

An external inspection of all the field erected boilers (B&W) revealed that there was no adjustability left in the FD fan linkage (to adjust the air / fuel ratio) on any of the

burners. To adjust the air/ fuel ratio the mechanical linkage will have to be revised. This may be as simple as drilling more holes in the lever arms, or, as complicated as adding adjustable cams. Either solution will be relatively inexpensive.

The B&W boilers have all been revised by changing them from front to rear firing units. The conservative 1942 design permits overfiring virtually doubling the steaming capacity to 20 - 25 thousand lbs/hr, without tube damage. The penalty for operating above the original design capacity is a substantial increase in exit gas temperature; the energy released exceeds the absorptive surface originally provided. Except on rare occasions, it is the operator's practice never to overfire these units.

All of the units except those in building 44120 return only 5 to 10 % condensate at best. In building 44120 approximately 90% is returned.

Potential ECO's include:

- Revising the burner control linkage to allow adjustment of air/ fuel ratio.
- Replacing the old boilers with new package boilers.
- Reducing main steam header pressure

Electric Motors

Data were taken on the motors stated in the SOW. An Amprobe "Harmonalyzer" was used to take readings on voltage and current on each motor. The instrument calculates the power factor from the readings, and also measures the harmonics on each circuit. Table 2 summarizes the motor data:

Table 2: Electric Motors Measurements

BLDG.	MOTOR	USE	DESIGN HP	DESIGN KW	MEAS. KW	MEAS. PF	COMMENTS
32060	GE	Compressor 1	150	112	81.3	0.58	
32060	GE	Compressor 2	150	112			Not functional
33060	GE	Compressor 1	150	112	86.1	0.80	
33060	GE	Compressor 2	150	112	67.0	0.45	
34140	GE	Compressor 1	150	112		0.76	One phase bad
34140	GE	Compressor 2	150	112			Not functional

BLDG.	MOTOR	USE	DESIGN HP	DESIGN KW	MEAS. KW	MEAS. PF	COMMENTS
34196	WEST. 1	Scrubber	100	75	58.1	0.88	Companion fan not functional
34196	WEST. 2	Scrubber	150	75			
34196		Vent Fan 1	800	597			Voltage too high for meter
34196		Vent Fan 2	800	597			Fan not functional
42210		Well Pump 1	150	112		0.51	KW readings questionable
42030		Well Pump 3	150	112	89.5	0.83	
42210		Pump 1	40	30	26.4	0.85	
42210		Pump 2	40	30	22.1	0.85	
42210		Pump 3	40	30	23.6	0.85	
42210		Pump 1	40	30	23.4	0.85	
42960	GOULD	Compressor	75	56			Back-up use only
42961	LINCOLN	Compressor	75	56	53.3	0.81	
42979	TECO	Draft Fan	350	261	131.3	0.75	

As can be seen, power factors were very low on several motors. Also several of the motors were not functional because the equipment was being repaired, or was otherwise not working.

The compressor in 42960 had been replaced with a newer model in 42961; the one in 42960 is used for emergencies only. Two large motors that are used for the scrubbers in the WP production area were not included in the SOW. Readings were taken on the one that was functional.

An additional trip may be scheduled prior to the Interim Submittal depending on the preliminary data analysis.

Warren File

RS&H
Reynolds, Smith and Hills, Inc.
Architectural, Engineering, Planning and Environmental Services

Memorandum

Date: March 1, 1996

To: US Army Engineer District, Little Rock
ATTN: CESWL-ED-DM (Mr. Mark Emmerling)
P. O. Box 867
Little Rock, AR 72203-0867

From: Carlos S. Warren, PhD, PE
Project Manager

Subject: Monthly Progress Report
Contract No. DACA01-94-0038/0004
Electrical Energy Demand and Usage and Heating Study
Pine Bluff Arsenal, Arkansas

The following progress was made on the subject project during the month of February 1996:

1. Survey data were cataloged and ECO evaluations were begun on the boiler and compressed air systems.

2. Survey data were cataloged for the motors. Recommendations for completing the data necessary for fulfilling the SOW will be forwarded via fax and/or telephone to PBA and LRCOE.

3. The data noted in the Entrance Survey minutes to be furnished by PBA has not yet been received.

Work planned for March 1996:

1. Continue analysis of survey data.

2. Continue preparation of Interim Report (due 26 April).

Copies to: N. Rimmer, Pine Bluff Arsenal
E. Hartman, US Army Engineer District, Little Rock
J. Martinez, US Army Engineer District, Little Rock
T. Battaglia, US Army Engineer District, Mobile

RS&H
Reynolds, Smith and Hills, Inc.
Architectural, Engineering, Planning and Environmental Services

Memorandum

Date: March 21, 1996

To: Commander
U.S. Army, Pine Bluff Arsenal
ATTN: SMCPB-EHN (Ms. Nancy Rimmer)
10020 Kabrich Circle
Pine Bluff, AR 71602-9500

From: Carlos S. Warren, PhD, PE
Project Manager

Subject: Site Survey, 26 - 29 March 1996
Combined Limited Energy Study, Pine Bluff Arsenal
Contract No. DACA01-94-0038/0004
AEP No. 694-1331-004/0300

The following individuals will participate in the subject site survey at Pine Bluff Arsenal:

PII Redacted

Name:	William T.Todd
[redacted]	[redacted]
Work Address:	4651 Salisbury Road
	Jacksonville, FL 32256
Work Phone:	904-279-2281
[redacted]	[redacted]
[redacted]	[redacted] Brown [redacted]

PII Redacted

Name:	George W. Fallon
[redacted]	[redacted]
Work Address:	4651 Salisbury Road
	Jacksonville, FL 32256
Work Phone:	904-279-2275
[redacted]	[redacted]
[redacted]	[redacted]

RS&H
Reynolds, Smith and Hills, Inc.
Architectural, Engineering, Planning and Environmental Services

Memorandum

Date: April 4, 1996

To: US Army Engineer District, Little Rock
ATTN: CESWL-ED-DM (Mr. Mark Emmerling)
P. O. Box 867
Little Rock, AR 72203-0867

From: Carlos S. Warren, PhD, PE
Project Manager

Subject: Monthly Progress Report
Contract No. DACA01-94-0038/0004
Electrical Energy Demand and Usage and Heating Study
Pine Bluff Arsenal, Arkansas

The following progress was made on the subject project during the month of March 1996:

1. In order to re-measure some data that were not consistent with expected values, and to take data on some items that were unavailable during the first site survey, two members of the RS&H team were on-site at PBA 26-28 March 1996.

2. Initial analysis of the PBA boiler data shows that an enormous amount of the boiler loads (> 50%) is due to leaks in the steam distribution lines. The leaks affect the ECO calculations because they cause boiler loads that are artificial. We need instructions on whether or not to assume that the steam lines will be replaced or repaired. An ECO to replace the existing lines is outside the present Scope of Work. If ECOs are recommended with the assumption that the lines are repaired or replaced, and they are not, the anticipated ECO savings will never be realized.

Work planned for March 1996:

1. Continue analysis of survey data.

2. Submit the Interim Report.

Copies to: N. Rimmer, Pine Bluff Arsenal
E. Hartman, US Army Engineer District, Little Rock
J. Martinez, US Army Engineer District, Little Rock

April 11, 1996

Enclosed is one copy each of Drawing B1-600-21, sheet 7 of 9 and sheet 8 of 9 (total of two drawings). These drawings are for use by Reynolds, Smith and Hills, Inc., of Jacksonville, FL on Contract No. DACA01-94-0038/0004, Combined Limited Energy Study. These drawings are for use on this project only and are to be returned at the conclusion of the project to:

Commander
Pine Bluff Arsenal
ATTN: SIOPB-PWN (Nancy Rimmer)
Pine Bluff, AR 71602-9500

RS&H

Reynolds, Smith and Hills, Inc.
Architectural, Engineering, Planning and Environmental Services

Facsimile Transmittal Letter

Date: April 25, 1996

To: Mark Emmerling, Project Manager, Little Rock COE

Fax Number: 501-324-6968

From: Bill Todd for Carlos S. Warren

Sender's Phone: (904) 279 - 2281

PTAC Number: 6690 **Dept. Number:** 3011

Project Number: 694-1331-004 **Task Number:** 0400

We are transmitting 9 pages including cover

Comments: This fax includes a revised schedule and suggested changes for a no cost modification to the Scope of Work for the Pine Bluff Arsenal Combined Electrical Demand and Heating Study. Based on our previous site surveys, we have eliminated some buildings and ECO's that were not good candidates for energy saving projects. An additional site visit has been scheduled for the week of May 6, 1996 to determine how much steam is being lost in the various sections of the steam distribution system. Carlos will be out of the office for about two weeks. Please call me at the above number if you would like to discuss the proposed changes.

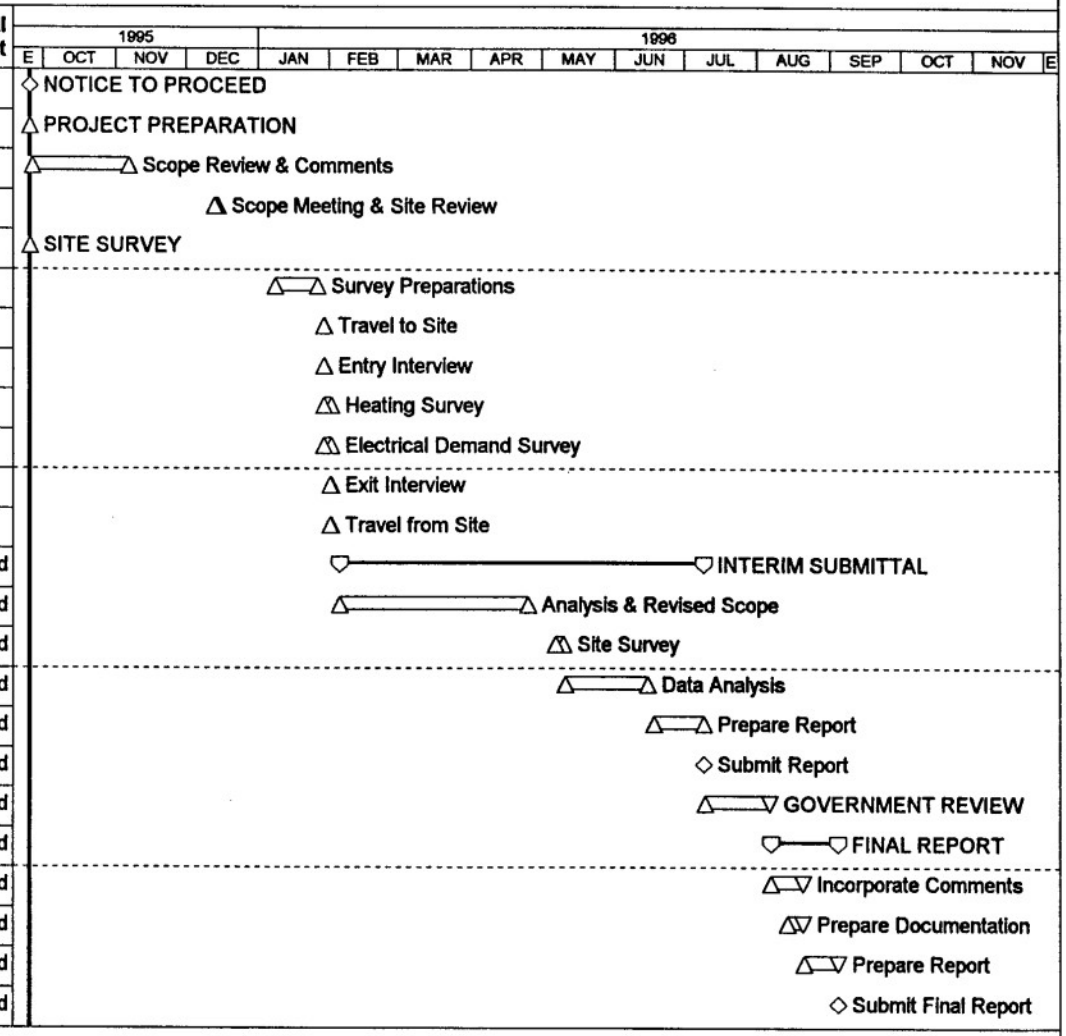
Reynolds, Smith and Hills, Inc.
4651 Salisbury Road
Jacksonville, Florida 32256
(904) 296-2000 Fax: (904) 279-2489
FL Cert. Nos. AAC001886 EB0005620 LCC000210

Report: Classic Gantt
Layout: Classic Gantt
Filter: All Activities

SureTrak Project Manager
PBA DEMAND & HEATING STUDY

REYNOLDS, SMITH AND HILLS, INC.
Report Date: 24APR96

Outline Code	Activity Description	Original Duration	Early Start	Early Finish	Total Float
1	NOTICE TO PROCEED	0	25SEP95 A		
2	PROJECT PREPARATION	0 *	25SEP95	25SEP95	
2.1	Scope Review & Comments	30d	26SEP95 A	06NOV95 A	
2.2	Scope Meeting & Site Review	2d	13DEC95 A	14DEC95 A	
3	SITE SURVEY	0 *	25SEP95	25SEP95	
3.1	Survey Preparations	15d	08JAN96 A	26JAN96 A	
3.2	Travel to Site	4h	29JAN96 A	29JAN96 A	
3.3	Entry Interview	1h	29JAN96 A	29JAN96 A	
3.4	Heating Survey	3d	29JAN96 A	01FEB96 A	
3.5	Electrical Demand Survey	3d	29JAN96 A	01FEB96 A	
3.6	Exit Interview	2h	01FEB96 A	01FEB96 A	
3.7	Travel from Site	4h	01FEB96 A	01FEB96 A	
4	INTERIM SUBMITTAL	109d *	05FEB96 *	08JUL96	-49d
4.1	Analysis & Revised Scope	58d	05FEB96	24APR96	-49d
4.2	Site Survey	4d	06MAY96	09MAY96	-49d
4.3	Data Analysis	25d	10MAY96	14JUN96	-49d
4.4	Prepare Report	15d	17JUN96	08JUL96	-49d
4.5	Submit Report	0		08JUL96	-49d
5	GOVERNMENT REVIEW	20d	09JUL96	05AUG96	14d
6	FINAL REPORT	20d *	06AUG96	03SEP96	14d
6.1	Incorporate Comments	10d	06AUG96	19AUG96	14d
6.2	Prepare Documentation	5d	13AUG96	19AUG96	14d
6.3	Prepare Report	10d	20AUG96	03SEP96	14d
6.4	Submit Final Report	0		03SEP96	14d



△	Early start point
▽	Early finish point
▭	Early bar
▭	Progress bar
▭	Critical bar
——	Summary bar
△	Progress point
△	Critical point
⛉	Summary point
◇	Start milestone point
◇	Finish milestone point

Data date	25SEP95
Start date	25SEP95
Finish date	03SEP96
Must finish date	23SEP96
Target finish date	

Date	Revision	Checked	Approved

Suggestions for a No Cost Modification to the PBA Scope of Work

ANNEX A - ELECTRICAL ENERGY DEMAND AND USAGE

Paragraph 3.a.
Eliminate Buildings 31-630, 32-620, 33-530 and 42-960. Either the compressors are no longer utilized or the entire building has been put in layaway.

Paragraph 4
Eliminate 4.a.(1) and 4.a.(2)
Eliminate 4.b.(1), 4.b.(2), 4.b.(3) and 4.b.(4)
Eliminate 4.c.(1)

ANNEX B - HEATING AND COMPRESSED AIR

Paragraph 4.a.
Eliminate Buildings 31-620, 31-630, 32-620, 33-530 and 42-960. Either the compressors are no longer utilized or the entire building has been put in layaway.

Paragraph 4.c.
Insert the following sentences (Insert A).

There is an ECIP project currently in progress to construct a new boiler house with two new 350 horsepower boilers. The new boiler house will be located north of Building 34-120 in the White Phosphorus Area. The new boilers will be connected to the existing high pressure steam main.

Paragraph 4.f.
Eliminate existing paragraph 4.f. (there is little if any energy use difference between the new compressors and the existing compressors) and insert the following new paragraph 4.f.(Insert B).

f. Determine the energy use and cost associated with leaks from the existing high pressure steam distribution system. Provide calculations, cost estimates and economic analysis for repairing or replacing the existing above ground steam distribution system between the boiler houses and the end use buildings.

Paragraph 6.
Insert the following sentence (Insert C).

The boiler and ECO analyses shall be based on the assumption that the existing high pressure steam distribution system will be repaired or replaced, and the current losses due to leaks in the steam piping system will be substantially reduced.

RS&H
Reynolds, Smith and Hills, Inc.
Architectural, Engineering, Planning and Environmental Services

Memorandum

Date: April 30, 1996

To: Commander
U.S. Army, Pine Bluff Arsenal
ATTN: SMCPB-EHN (Ms. Nancy Rimmer)
10020 Kabrich Circle
Pine Bluff, AR 71602-9500

From: Carlos S. Warren, PhD, PE
Project Manager

Subject: Site Survey, 06 - 10 May 1996
Combined Limited Energy Study, Pine Bluff Arsenal
Contract No. DACA01-94-0038/0004
AEP No. 694-1331-004/0300

The following individuals will participate in the subject site survey at Pine Bluff Arsenal:

PII Redacted

Name: William T.Todd
[redacted]
Work Address: 4651 Salisbury Road
Jacksonville, FL 32256
Work Phone: 904-279-2281
[redacted]

PII Redacted

Name: George W. Fallon
[redacted]
Work Address: 4651 Salisbury Road
Jacksonville, FL 32256
Work Phone: 904-279-2275
[redacted]

A.8-22

f:\pba\survey3.wpd

RECEIVED MAY 14 1996

DEPARTMENT OF THE ARMY
LITTLE ROCK DISTRICT, CORPS OF ENGINEERS
POST OFFICE BOX 867
LITTLE ROCK, ARKANSAS 72203-0867

REPLY TO
ATTENTION OF

CESWL-ED-DM 7 May 1996

MEMORANDUM FOR Commander, U.S. Army Engineer District, Mobile, ATTN: CESAM-EN-DM (Mr. Tony Battaglia), 109 St. Joseph Street, P.O. Box 2288, Mobile, AL 36628

SUBJECT: Energy Engineering Analysis Program (EEAP), Electrical Energy Demand and Usage and Heating Study, Pine Bluff Arsenal, Delivery Order No. 0004, Contract No. DACA01-94-D-0038

1. The AE has suggested stopping a majority of the motor ECOs and eliminating some motors since he feels they were not good candidates for energy savings due to limited operating hours. In lieu of this, he has suggested pursuing a new ECO (steam loss). He feels the new ECO will provide more energy savings. We recommend approval of the substitutions to be processed as a no-cost modification.

2. The site survey and initial investigation of ECOs on the PBA boiler data shows an enormous amount of the boiler load (>50%) is due to leaks in the steam distribution lines. We estimate about 5.5 miles of steam distribution branch lines or legs and 2 miles of header line or "high-line" exists. The DPW feels that most of the leaks are on the high-line (approximately 75%). The AE will provide an additional site survey the week of 13 May 1996 to determine how much steam is being lost in the various sections of the steam distribution system.

3. The user has jobs on-going that relate to the subject study. They are as follows:

a. Little Rock District, Corps of Engineers, Project No. 42341, Steam and Condensate System (ECIP), Pine Bluff Arsenal - Consists of replacement of exterior condensate piping in Production Area 3, Sections 1, 2, and 3 at Pine Bluff Arsenal (this is inclusive of the legs branching off the header or "high-line", approximately 5.5 miles of lines). New electric motor driven pump stations are also included. Repair/replacement of pipe supports is also included.

b. Pine Bluff Arsenal, DPW, In-house Project, Steam Line Replacement - Consisted of replacing steam lines using relatively new piping on-hand left over from the Binary Projects (this was inclusive of the legs branching off the header or "high-line", approximately 1 mile, Production Area 3, Sections 1, 2, and 3).

The DPW has also programmed in the 5 year maintenance plan to replace more steam lines where leaking is identified on the legs as money becomes available.

c. Little Rock District, Corps of Engineers, Project No. 33574, Boiler Improvements - ECIP, Pine Bluff Arsenal - Consists of a new boiler house with two new 350 HP boilers north of building 34-120, in the White Phosphorus area. The new boilers will be connected to the existing high pressure steam main "high-line or header" as it is called.

4. From the above it appears that most of the branch steam and condensate return lines will be replaced/repaired by other projects. The user has requested that if the steam loss ECO is accepted and the steam "high-line" is replaced, provisions be made for the condensate return also. It should be noted by the AE that the existing steam high-line contains asbestos insulation and that the user wants the old line active while constructing the new line.

5. The type of work has not changed, the area to be surveyed has not changed, and the level of effort has not changed. Enclosed you will find the Standard Form 30, the modified Annexes, and AE correspondence. For questions, please contact Joe Martinez at (501) 324-6172 or Mark Emmerling at (501) 324-6905.

FOR THE COMMANDER:

Encl

Edward Z. Lofton
EDWARD Z. LOFTON, P.E.
Contracting Officer's
Representative

CF:
Dr. Carlos Warren, Reynolds, Smith and Hills, Inc., 4651 Salisbury Road, Jacksonville, Florida 32256

AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT

1. CONTRACT ID CODE

PAGE 1 OF PAGES 1

2. AMENDMENT/MODIFICATION NO.	3. EFFECTIVE DATE	4. REQUISITION/PURCHASE REQ. NO.	5. PROJECT NO. *(If applicable)*
02			

ISSUED BY — CODE W41XDE

US ARMY ENGINEER DISTRICT, MOBILE
P.O. BOX 2288
MOBILE, ALABAMA 36628-0001

7. ADMINISTERED BY *(If other than Item 6)* — CODE

US ARMY ENGINEER DISTRICT, LITTLE ROCK
P.O. BOX 867
LITTLE ROCK, AR 72203-0867

8. NAME AND ADDRESS OF CONTRACTOR *(No., street, county, State and ZIP code)*

REYNOLDS, SMITH AND HILLS, INC.
4651 SALISBURY ROAD
JACKSONVILLE, FLORIDA 32256

CODE | FACILITY CODE

(X)	
	9A. AMENDMENT OF SOLICITATION NO.
	9B. DATED *(SEE ITEM 11)*
X	10A. MODIFICATION OF CONTRACT/ORDER NO. Delivery order No. 0004 Contract DACA01-94-0038
	10B. DATED *(SEE ITEM 13)* 95 SEP 12

11. THIS ITEM ONLY APPLIES TO AMENDMENTS OF SOLICITATIONS

☐ The above numbered solicitation is amended as set forth in Item 14. The hour and date specified for receipt of Offers ☐ is extended, ☐ **is not extended.** Offers must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation or as amended, by one of the following methods: (a) By completing Items 8 and 15, and returning ____ copies of the amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGEMENT TO BE RECEIVED AT THE PLACE DESIGNATED FOR THE RECEIPT OF OFFERS PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided each telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

12. ACCOUNTING AND APPROPRIATION DATA *(If required)*

52050 08-8071 P7000 S34066 RA521250001B400 $92,554.00 TOTAL DIRECT CITE ORG: NT

13. THIS ITEM APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS, IT MODIFIES THE CONTRACT/ORDER NO. AS DESCRIBED IN ITEM 14.

(X)	
	A. THIS CHANGE ORDER IS ISSUED PURSUANT TO: *(Specify authority)* THE CHANGES SET FORTH IN ITEM 14 ARE MADE IN THE CONTRACT ORDER NO. IN ITEM 10A.
	B. THE ABOVE NUMBERED CONTRACT/ORDER IS MODIFIED TO REFLECT ADMINISTRATIVE CHANGES *(such as changes in paying office, appropriation date, etc.)* SET FORTH IN ITEM 14, PURSUANT TO AUTHORITY OF FAR 43.103(b).
X	C. THIS SUPPLEMENTAL AGREEMENT IS ENTERED INTO PURSUANT TO AUTHORITY OF: Contract Clause No. 57, CHANGES--FIXED-PRICE (ALTERNATE III)
	D. OTHER *(Specify type of modification and authority)*

E. IMPORTANT: Contractor ☐ is not, ☒ is required to sign this document and return origin copies to the issuing office.

14. DESCRIPTION OF AMENDMENT/MODIFICATION *(Organized by UCF section headings, including solicitation/contract subject matter where feasible.)*

This no cost Modification is issued to modify Energy Conservation Opportunities (ECO's) in the Scope of Work due to identification of new ECOs which offer more energy savings. Paragraph 3.a, 4.a, 4.b, and 4.c in Annex A and paragraph 3.a.1, 4.c, 4.f, and 6 in Annex B have been revised to reflect these changes.

Except as provided herein, all terms and conditions of the document referenced in Item 9A or 10A, as heretofore changed, remains unchanged and in full force and effect.

A. NAME AND TITLE OF SIGNER *(Type or print)*		16A. NAME AND TITLE OF CONTRACTING OFFICER *(Type or print)*	
los S. Warren, PhD, PE , Project Manager		Gene L. Curtis	
. CONTRACTOR/OFFEROR	15C. DATE SIGNED	16B. UNITED STATES OF AMERICA	16C. DATE SIGNED
____ *(Signature of person authorized to sign)*		BY ____ *(Signature of Contracting Officer)*	

RECEIVED MAY 2 9 1996

May 22, 1996

Enclosed is one copy each of Drawing B1-600-21, sheet 7 of 9 and sheet 8 of 9 (total of two drawings). These drawings are for use by Reynolds, Smith and Hills, Inc., of Jacksonville, FL on Contract No. DACA01-94-0038/0004, Combined Limited Energy Study. These drawings are for use on this project only and are to be returned at the conclusion of the project to:

Commander
Pine Bluff Arsenal
ATTN: SIOPB-PWN (Nancy Rimmer)
Pine Bluff, AR 71602-9500

RS&H

Reynolds, Smith and Hills, Inc.
Architectural, Engineering, Planning and Environmental Services

Memorandum

Date: June 6, 1996

To: US Army Engineer District, Little Rock
ATTN: CESWL-ED-DM (Mr. Martinez; Ms. Hartman)
P. O. Box 867
Little Rock, AR 72203-0867

From: Carlos S. Warren, Ph.D., PE
Project Manager

Subject: Monthly Progress Report
Contract No. DACA01-94-0038/0004
Electrical Energy Demand and Usage Study and Heating Study
Pine Bluff Arsenal, Arkansas

The following progress was made on the subject contract during the month of May 1996:

1. A no-cost modification was made to the contract Scope of Work to include a determination of the energy use and cost of leaks in the high-pressure steam line at PBA. Several ECOs involving unused motors were deleted by the modification. The modification was received by RS&H on 14 May 1996.

2. A field survey was conducted by RS&H the week of 13 May 1996 to locate the steam leaks and to gather data for the analysis.

3. Analysis of the steam leaks was begun. A revised schedule was developed and submitted (attached). The revised date for the submission of the Interim Report is 8 July 1996.

Work planned for June 1996:

Complete analysis and begin preparation of the Interim Report.

Attachment

CC: N. Rimmer, Pine Bluff Arsenal
M. Emmerling, Little Rock COE
W. Todd

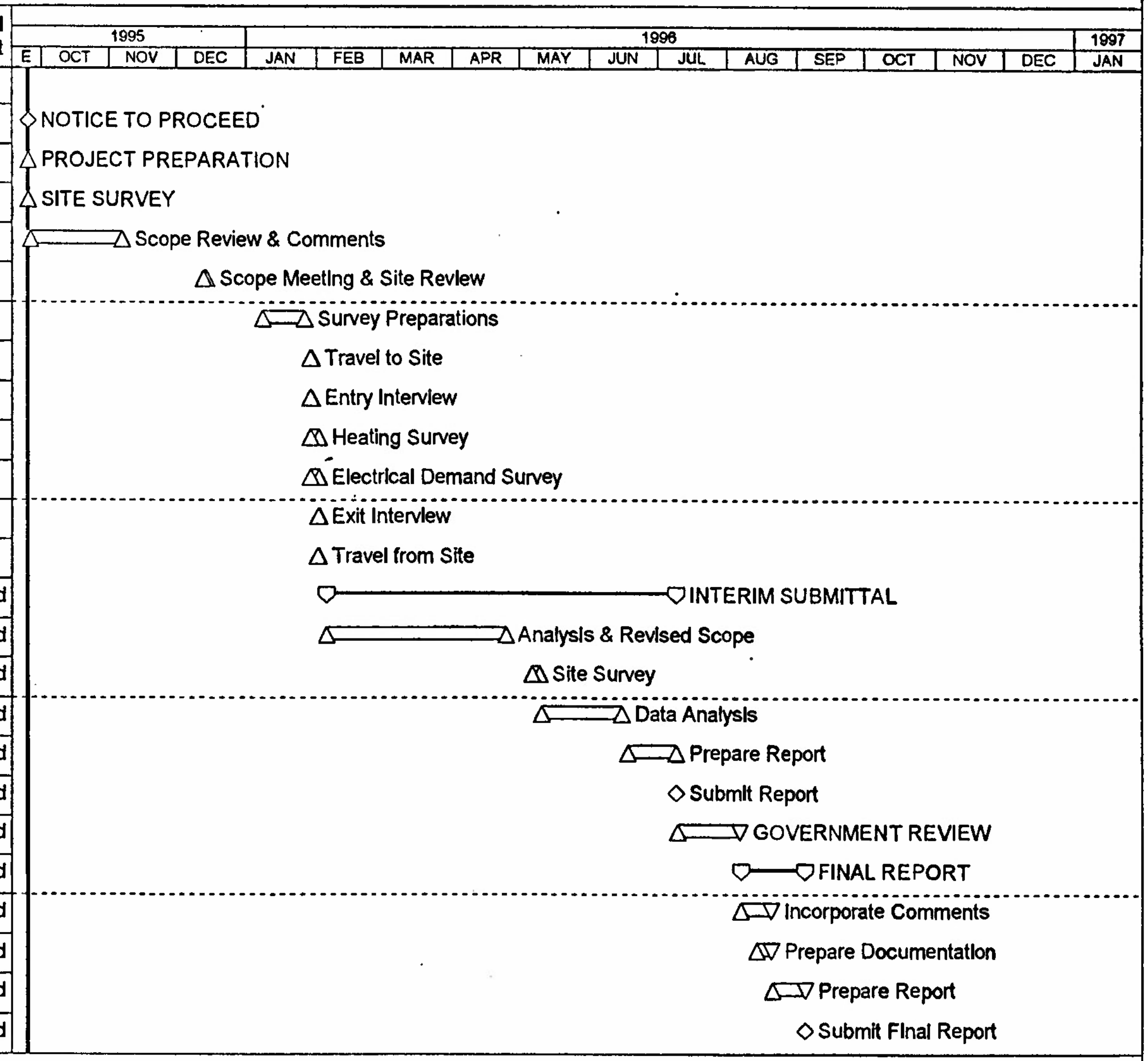
F:\PBA\MAY_RPT.DOC

Report: Classic Gantt
Layout: Classic Gantt
Filter: All Activities

SureTrak Project Manager
PBA DEMAND & HEATING STUDY

REYNOLDS, SMITH AND HILLS, INC.
Report Date: 04JUN96

Outline Code	Activity Description	Original Duration	Early Start	Early Finish	Total Float
PBA DEMAND & HEATING STUDY					
1	NOTICE TO PROCEED	0	25SEP95		
2	PROJECT PREPARATION	0 *	25SEP95	25SEP95	
3	SITE SURVEY	0 *	25SEP95	25SEP95	
2.1	Scope Review & Comments	30d	26SEP95	06NOV95	
2.2	Scope Meeting & Site Review	2d	13DEC95	14DEC95	
3.1	Survey Preparations	15d	08JAN96	26JAN96	
3.2	Travel to Site	4h	29JAN96	29JAN96	
3.3	Entry Interview	1h	29JAN96	29JAN96	
3.4	Heating Survey	3d	29JAN96	01FEB96	
3.5	Electrical Demand Survey	3d	29JAN96	01FEB96	
3.6	Exit Interview	2h	01FEB96	01FEB96	
3.7	Travel from Site	4h	01FEB96	01FEB96	
4	INTERIM SUBMITTAL	109d *	05FEB96 *	08JUL96	-49d
4.1	Analysis & Revised Scope	58d	05FEB96	24APR96	-49d
4.2	Site Survey	4d	06MAY96	09MAY96	-49d
4.3	Data Analysis	25d	10MAY96	14JUN96	-49d
4.4	Prepare Report	15d	17JUN96	08JUL96	-49d
4.5	Submit Report	0		08JUL96	-49d
5	GOVERNMENT REVIEW	20d	09JUL96	05AUG96	14d
6	FINAL REPORT	20d *	06AUG96	03SEP96	14d
6.1	Incorporate Comments	10d	06AUG96	19AUG96	14d
6.2	Prepare Documentation	5d	13AUG96	19AUG96	14d
6.3	Prepare Report	10d	20AUG96	03SEP96	14d
6.4	Submit Final Report	0		03SEP96	14d



Legend		
△ Early start point	△ Progress point	
▽ Early finish point	△ Critical point	
Early bar	Summary point	
Progress bar	◇ Start milestone point	
Critical bar	◇ Finish milestone point	
Summary bar		

Data date	25SEP95
Start date	25SEP95
Finish date	03SEP96
Must finish date	23SEP96
Target finish date	

Date	Revision	Checked	Approved

A.8-28

RS&H

Facsimile Transmittal Letter

Reynolds, Smith and Hills, Inc.
Architectural, Engineering, Planning and Environmental Services

Date: June 24, 1996

To: Nancy Rimmer / Roch Byrne

Fax Number: 501-540-3251

From: Bill Todd

Sender's Phone: (904) 279- 2281

PTAC Number:	6690	**Dept. Number:**	3011
Project Number:	694-1331-004	**Task Number:**	0400

We are transmitting 2 **pages including cover**

Comments: The attached list shows all of the Area 3 production buildings (that we know of) that require compressed air. The maximum compressed air demand listed for these buildings assumes all production lines in each building are operational at the same time. Since the total compressed air demand is almost twice as much as the existing compressors can produce, there must be some compressors at the individual buildings and/or the buildings and lines do not operate at the same time. Please indicate on this list what the average compressed air loads would be during production shifts and non-production times (nights, weekends, etc.) and if any of these buildings has its own dedicated compressed air system. Thanks for your help.

Reynolds, Smith and Hills, Inc.
4651 Salisbury Road
Jacksonville, Florida 32256
(904) 296-2000 Fax: (904) 279-2491
FL Cert. Nos.
AC001886-EB0005620-LCC000210

A.8-29

PBA Electric and Heating Study
Compressed Air Requirements

Bldg No.	Maximum Air Demand (cfm)	Average Air Demand (cfm) (current prod.)	Minimum Air Demand (cfm) (weekends)	Air Supplied by Main Plant	Air Supplied by Indiv. Comp.
31530	200				
31620	200				
31630	1800				
31640	10				
31720	10				
Subtotal	2220				
32070	10				
32230	400				
32270	1800				
32610	100				
32620	178				
32640	1200				
Subtotal	3688				
33530	2100				
33620	10				
33670	600				
Subtotal	2710				
34110	600				
34630	120				
34640	100				
Subtotal	820				
Total	9438				

Current capacity = 825 cfm x 6 compressors = 4950 cfm

RS&H
Reynolds, Smith and Hills, Inc.
Architectural, Engineering, Planning and Environmental Services

Telephone Call Confirmation

Date: June, 26, 1996

Project Number: 694-1331-004

Project Name: PBA Electric and Heating Study

Received: **Placed:** by W. Todd

Local: **Long Dist.:** 800-330-1379

Conversed with: Robert Robinete

of Arkansas Power & Light Co.

Regarding: PBA Electric Rate

Contracted Demand Limit: There is no upper contracted demand limit on PBA's rate. There is no peak demand time on their rate. There is a minimum demand of 1000 kW, but PBA never gets that low. Their lowest monthly demand over the past 12 months was 2227 kW. If they shut down for a month their minimum bill would be $2.57 per kW times the maximum kW over the last 12 months.

A/C Switch Credit: A credit because AP&L can control some of the HVAC systems in the housing facilities at PBA.

Decommissioning Cost: Charge imposed by the PSC - they are paying for some nuclear power plants that are not even in Arkansas.

Robert is no longer the rep. for PBA. The new rep. is David Burnett and his phone number is 501-541-4747. Robert was the rep. for a while and he may be able to answer some questions that David may not know.

Distribution: By: W. T. Todd

RS&H
Reynolds, Smith and Hills, Inc.
Architectural, Engineering, Planning and Environmental Services

Memorandum

Date: July 5, 1996

To: US Army Engineer District, Little Rock
ATTN: CESWL-ED-DM (Mr. Martinez; Ms. Hartman)
P. O. Box 867
Little Rock, AR 72203-0867

From: Carlos S. Warren, Ph.D., PE
Project Manager

Subject: Monthly Progress Report
Contract No. DACA01-94-0038/0004
Electrical Energy Demand and Usage Study and Heating Study
Pine Bluff Arsenal, Arkansas

The following progress was made on the subject contract during the month of June 1996:

1. Analysis of the ECOs was completed. Four electrical, ten heating, and three compressed air ECOs were evaluated.

2. Preparation of the Interim Report was begun.

Work planned for July 1996:

Complete and submit the Interim Report on 8 July as scheduled.

CC: N. Rimmer, Pine Bluff Arsenal
M. Emmerling, Little Rock COE
A. Battaglia, Mobile COE
W. Todd

F:\PBA\JUN_RPT.DOC

Transmittal Letter

Reynolds, Smith and Hills, Inc.
Architectural, Engineering, Planning and Environmental Services

---

To: Attached Distribution List **Date:** July 5, 1996

Project: Limited Energy Study, Combined Electrical Demand and Heating Pine Bluff Arsenal, Arkansas **Project No.:** 694-1331-004

We Transmit:

(X) Herewith ( ) Via Fax ( ) Hand Carried
( ) Under Separate Cover Via:
( ) In Accordance with Your Request
( ) Regular Mail (X) Overnight Mail ( ) Courier

For Your:

( ) Approval
( ) Review and Comment
(X) Use
( ) Signature

The Following:

Copies	Date	Description
As per distribution list	July 1996	Vol. I Narrative Report, Interim Submittal
As per distribution list	July 1996	Vol. II Appendicies
As per distribution list	July 1996	Vol. III Field Investigation Forms

Remarks:

Please retain Volume II and Volume III. Volume III is in its final form and replacement pages will be sent for the final submittal of Volume II.

/kw
Copies To:

Reynolds, Smith and Hills, Inc.
4651 Salisbury Road
Jacksonville, Florida 32256
(904) 296-2000 Fax: (904) 279-2491

FL Cert. Nos. AAC001886•EB0005620•LCC000210

By: Carlos Warren

Carlos Warren, PhD, PE
Project Manager

l:todd\les07-5.tra

Limited Energy Study
Combined Electrical Demand and Heating
Pine Bluff Arsenal, Arkansas

INTERIM REPORT

No. Copies

Volume I	Volume II	Volume III	
5	5	1	Commander U. S. Army, Pine Bluff Arsenal Attn: SMCPB-EHN (Ms. Rimmer) 10020 Kabrich Circle Pine Bluff, AR 71602-9500
1	1	0	Commander U. S. AMC Installation and Service Activity Attn: AMXEN-C (Mr. Nache) Rock Island, IL 61299-7190
1	1	1	Commander U. S. Army Engineer District, Little Rock Attn: CESWL-ED-DM (Mr. Emmerling) 700 West Capitol Little Rock, AR 72203-0867
1	1	0	Commander U. S. Army Engineer Division, Southwest Attn: CESWD-PP-MM (Mr. ~~West~~) Bowen 1114 Commerce Street Dallas, TX 75242-0216
1	1	0	Commander U. S. Army Engineer District, Mobile Attn: CESAM-EN-DM (Mr. Battaglia) P. O. Box 2288 Mobile, AL 36628
0	0	0	Commander U. S. Army Corps of Engineers Attn: CEMP-ET (Mr. Gentil) 20 Massachusetts Avenue NW Washington, DC 20314-1000
0	0	0	Commander U. S. Army Logistics Evaluation Agency Attn: LOEA-PL (Mr. Keath) New Cumberland Army Depot New Cumberland, PA 17070-5007

Summary of trip conclusions, 7/23/96, Pine Bluff Arsenal EEAP Interim Submittal by RS&H, July 1996.

Attendees: Nancy & Ralph Rimmer, Kurt Williams, Don Faust, Exa Hartman, Joe Martinez

Summary of Recommended ECO□s accepted or rejected by Pine Bluff Arsenal:

Rejected:

H2-B Improve Efficiency of Existing Boilers (Tot cost $7,140) and H2-C Install Surplus Boilers and Add Economizers (Tot cost $298,000) in Bldg 32-060: Project to replace existing boilers in Bldg 32-060 with surplus boilers is currently under construction.

E-4 Replace the filtered water pump motors in Building 42-210 with energy efficient motors (Tot cost $8,320).

ECO Rejected by Comment No. 8 from Anthony Battaglia, CESAM-EN-DM 10 July, 1996 for having a payback greater than 10 years.

Accepted by PBA:

H1-A Repair existing steam pipe and fittings (Tot cost $77,920)

C3-C Repair existing compressed air pipe and fittings (Tot cost $83,680)

H3-B Improve efficiency of existing boilers in Building 33-060 (Tot cost $7,140)

H4-B Improve efficiency of existing boilers in Building 34-140 (Tot cost $10,721).

Arsenal Requested Combinations:

Combine H4-B Improve efficiency of existing boilers in Bldg 34-140 (Sir:52.3, Simp Pybk: 0.4 yr, $/yr Savings: $30,130) with H4-C Install dearator on new or existing boilers (Sir:1.64, Simp Pybk: 11.4 yrs, $/yr Savings: $5,440) Combined tot cost of $72,470. Combined Simple payback: 2.04 yrs w/apparent SIR within the 1.25 max.

Sum of Accepted and Requested Construction Costs Above:$251,931

Arsenal requests that H4-A Bldg 34-140 and H3-A Bldg 33-060 be re-studied as Consider the Addition of Economizers to Existing Boilers.

RS&H

Reynolds, Smith and Hills, Inc.
Architectural, Engineering, Planning and Environmental Services

Memorandum

Date: August 5, 1996

To: US Army Engineer District, Little Rock
ATTN: CESWL-ED-DM (Mr. Martinez; Ms. Hartman)
P. O. Box 867
Little Rock, AR 72203-0867

From: Carlos S. Warren, Ph.D., PE
Project Manager

Subject: Monthly Progress Report
Contract No. DACA01-94-0038/0004
Electrical Energy Demand and Usage Study and Heating Study
Pine Bluff Arsenal, Arkansas

The following progress was made on the subject contract during the month of July 1996:

1. The Interim Report was submitted for review on 8 July as scheduled.

2. Comments on the Interim Report were received from the Reviewers in a timely fashion. The responses to the comments were mailed on 16 July.

3. The Interim Review Conference was scheduled for 9 August.

Work planned for August 1996:

1. Attend and present findings at the Interim Review Conference.

2. Begin preparation of the Final Submittal Report.

CC: N. Rimmer, Pine Bluff Arsenal
A. Battaglia, Mobile COE
W. Todd

F:\PBA\JUL_RPT.DOC

US ARMY ENGINEER DISTRICT, MOBILE
PO BOX 2288
Mobile, Alabama, 36628-0001

Fax Cover Sheet

DATE:	August 14, 1996	**TIME:**	1:58 PM
TO:	Bill Todd, RSH Jacksonville, FL	**PHONE:** **FAX:**	(904) 279-2275 (904) 279-2491
FROM:	Tony Battaglia, CESAM-EN-DM USAED, Mobile, AL	**PHONE:** **FAX:**	(334) 690-2618 (334) 690-2424
RE:	Combined Limited Energy Study, Pine Bluff Arsenal, AR		

Number of pages including cover sheet: 2

Message

Bill:

Nancy Rimmer from PBA called today, and we discussed possible groupings of the ECOs for projects. The resulting suggestions are attached. I can't say this will be her final decision, but it is a start. Please call if you have any questions.

Tony Battaglia

SUGGESTED GROUPING OF ECOs for PROJECT DOCUMENTATION
COMBINED LIMITED ENERGY STUDY
PINE BLUFF ARSENAL, AR

PROJECT	ECO	DESCRIPTION	TYPE
1.	H1-A	Repair existing steam pipe & fittings	FEMP Project
2.	H2-B H3-B	B/32-060, Improve eff of existing boilers B/33-060, Improve eff of existing boilers	Combined FEMP project
3.	H4-B H4-C	B/34-140, Improve eff of existing boilers B/34-140, Install deaerator on boilers	Combined FEMP project
4.	C3-C	Repair existing compressed air pipe & fittings	FEMP Project
5.	F4	Replace filtered water pump motors	FEMP Project

Transmittal Letter

Reynolds, Smith and Hills, Inc.
Architectural, Engineering, Planning and Environmental Services

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To: Attached Distribution List **Date:** August 14, 1996

Project: Limited Energy Study, Combined Electrical Demand and Heating Pine Bluff Arsenal, Arkansas **Project No.:** 694-1331-004

We Transmit:

(X) Herewith ( ) Via Fax ( ) Hand Carried
( ) Under Separate Cover Via:
( ) In Accordance with Your Request
( ) Regular Mail (X) Overnight Mail ( ) Courier

For Your:

(X) Approval
( ) Review and Comment
( ) Use
( ) Signature

The Following:

Copies	Date	Description
1	8-14-96	Response to Review Comments-Review Meeting
1	8-8-96	Response to Review Comments-R. Rimmer
1	8-8-96	Response to Review Comments-A. Battaglia

Remarks: These are our responses to all comments regarding the Interim Submittal. Unless we are notified to the contrary, we will assume the review action comments are acceptable and proceed with the Final Submittal.

/kw
Copies To: C. Warren
File

Reynolds, Smith and Hills, Inc.
4651 Salisbury Road
Jacksonville, Florida 32256
(904) 296-2000 Fax: (904) 279-2491

FL Cert. Nos. AAC001886•EB0005620•LCC000210

By: William T. Todd
William T. Todd, PE

I:todd\les08-14.tra

Limited Energy Study
Combined Electrical Demand and Heating
Pine Bluff Arsenal, Arkansas

INTERIM REPORT - RESPONSE TO COMMENTS

Commander
U. S. Army Engineer District, Little Rock
Attn: CESWL-ED-DM (Mr. Martinez)
700 West Capitol
Little Rock, AR 72203-0867

Commander
U. S. Army Engineer District, Little Rock
Attn: CESWL-ED-DM (Ms. Hartman)
700 West Capitol
Little Rock, AR 72203-0867

DEPARTMENT OF THE ARMY
PINE BLUFF ARSENAL
PINE BLUFF, ARKANSAS 71602-9500

REPLY TO ATTENTION OF
SIOPB-PWN

15 August 1996

MEMORANDUM FOR Commander, Little Rock District,
Corps of Engineers,
ATTN: CESWLED-DM (Mr. Martinez)
P.O. Box 867,
Little Rock, AR 72203-0867

SUBJECT: Contract No. DACA01-94-0038/0004, Electrical Energy Demand and Usage Study and Heating Study, Pine Bluff Arsenal

1. As requested by Reynolds, Smith and Hills representatives at the pre-interim submittal meeting for subject contract, energy conservation opportunities should be prepared for Federal Energy Management Program (FEMP) funding as follows:

PROJ	ECO	DESCRIPTION	TYPE
a.	H1-A	Repair existing steam pipe & fittings	FEMP Proj
b.	(H2-B	Bldg 32-060, Improve efficiency of existing boilers	Combined
	(H3-B	Bldg 33-060, Improve efficiency of existing boilers	FEMP Proj
c.	C3-C	Repair existing compressed air pipe and fittings	FEMP Proj
d.	E4	Replace filtered water pump motors	FEMP Proj

2. Documentation required for each project is the front sheet of the 1391 containing the project title and indication that the project is for FEMP funding, the life cycle cost analysis (LCCA) summary sheet completely filled out, a description of the work to be accomplished, backup data for the LCCA (i.e., energy and non-energy savings calculations and cost estimate), the savings-to-investment ratio (SIR), and the simple payback period.

FOR THE COMMANDER:

A.8-41

Willie E. Thomas

WILLIE E. THOMAS

FACSIMILE TRANSMITTAL HEADER SHEET

For use of this form, see AR 25-11; the proponent agency is ODISC4

	COMMAND/ OFFICE	NAME/ OFFICE SYMBOL	OFFICE TELEPHONE NO. (AUTOVON/Comm.)	FAX NO. (AUTOVON/Comm.)
FROM:	Joe Martinez	CESWLED-DM	501-324-6172	501-324-6968
TO:	Bill Todd	Reynolds, Smith & Hill, Inc.	904-296-2000	904-279-2491

CLASSIFICATION	PRECEDENCE	NO. PAGES (Including this Header)	DATE-TIME	MONTH	YEAR	RELEASER'S SIGNATURE
U	R	3	8/15	8	96	Joe Martinez

REMARKS

Project # 694-1331-004 Limited ES, Combined Elect Dmnd & Heating - PBA

Space Below For Communications Center Use Only

DA FORM 3918-R, JUL 90 DA FORM 3918-R, AUG 72 IS OBSOLETE

Pine Bluff Arsenal

U.S. ARMY

INDUSTRIAL OPERATIONS COMMAND

PINE BLUFF ARSENAL

PINE BLUFF, ARKANSAS

TO: Little Rock Dist, CE ATTN: CESWLED-OM (Joe Martinez) DATE: 15 Aug 96

Phone: ~~DSN~~: (501) 324-6172 FAX: (501) 324-6968

CLASSIFICATION: Unclass NO. OF PGS. cover sheet + 1

PRECEDENCE: Routine

REMARKS:

SIOPB-PWN - PBA

FROM: Nancy Rimmer

FAX: (501) 540-3251

PHONE: (501) 540-3312

RELEASER'S SIGNATURE: Nancy Rimmer